



## STPC<sup>®</sup> CONSUMER-S

### PC Compatible Embedded Microprocessor

- POWERFUL x86 PROCESSOR
- 64-BIT 66MHz SDRAM UMA CONTROLLER
  - SUPPORTS 16Mbit SDRAMs (4MX4, 2MX8, 1MX16).
- VGA & SVGA CRT CONTROLLER
- 2D GRAPHICS ENGINE
- VIDEO INPUT PORT
- VIDEO PIPELINE
  - UP-SCALER
  - VIDEO COLOR SPACE CONVERTER
  - CHROMA & COLOUR KEY SUPPORT
- TV OUTPUT
  - 3-LINE FLICKER FILTER
  - CCIR 601/656 SCAN CONVERTER
  - NTSC / PAL COMPOSITE, RGB, S-VIDEO
- PCI MASTER / SLAVE CONTROLLER
- ISA MASTER / SLAVE CONTROLLER
- INTEGRATED PERIPHERAL CONTROLLER
  - DMA CONTROLLER
  - INTERRUPT CONTROLLER
  - TIMER / COUNTERS
- OPTIONAL 16-BIT LOCAL BUS INTERFACE
- EIDE CONTROLLER
- I<sup>2</sup>C INTERFACE
- POWER MANAGEMENT UNIT
- 3.45V OPERATION

### STPC CONSUMER-S OVERVIEW

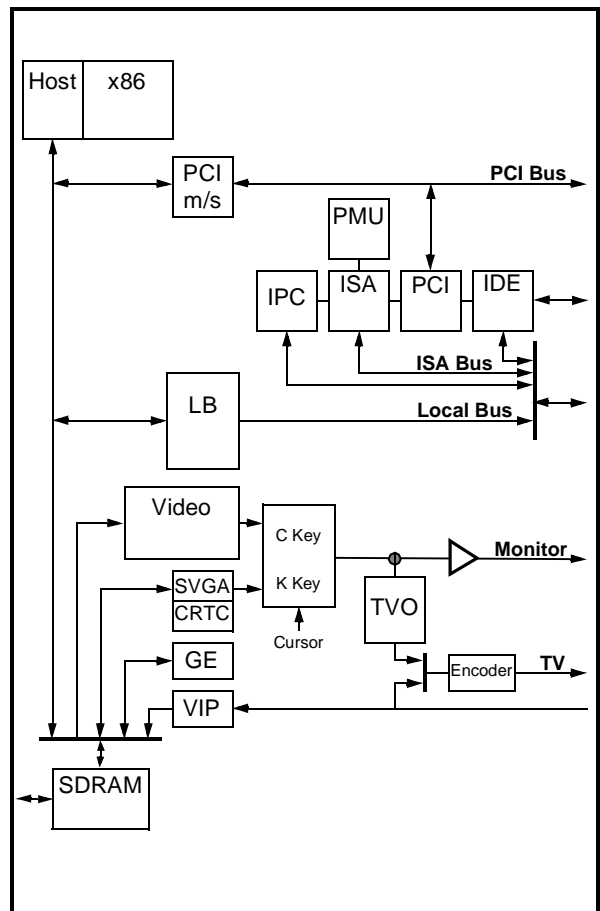
The STPC Consumer-S integrates a standard 5th generation x86 core, a Synchronous DRAM controller, a graphics subsystem, a video input port, video pipeline, and support logic including PCI, ISA, and IDE controllers to provide a single consumer orientated PC compatible subsystem on a single device.

The device is based on a tightly coupled Unified Memory Architecture (UMA), sharing the same memory array between the CPU main memory and the graphics and video frame buffers.

The STPC Consumer-S is packaged in a 388 Plastic Ball Grid Array (PBGA).



Figure 0-1. Logic Diagram



## STPC CONSUMER-S OVERVIEW

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### ■ X86 Processor core

- Fully static 32-bit 5-stage pipeline, x86 processor fully PC compatible.
- Can access up to 4GB of external memory.
- 8Kbyte unified instruction and data cache with write back and write through capability.
- Parallel processing integral floating point unit, with automatic power down.
- Fully static design for dynamic clock control.
- Low power and system management modes.

### ■ SDRAM Controller

- 64-bit data bus.
- Up to 66MHz SDRAM clock speed.
- Integrated system memory, graphic frame memory and video frame memory.
- Supports 2MB up to 128 MB memory.
- Supports 8MB, 16M, and 32MB DIMMS.
- Supports buffered, non buffered, and registered DIMMS.
- 4-line write buffers for CPU to DRAM and PCI to DRAM cycles.
- 4-line read prefetch buffers for PCI masters.
- Programmable latency
- Programmable timing for DRAM parameters.
- Supports -8, -10 memory parts
- Supports 1MB up to 8MB memory hole.
- 32-bit accesses not supported.
- Autoprecharge not supported.
- Power down not supported.
- FPM and EDO not supported.
- Supports 16M-bit full page mode SDRAMs (1M x 16, 2M x 8 & 4M x 4)

### ■ Graphics Controller

- 64-bit windows accelerator.
- Compatibility to VGA & SVGA standards.
- Hardware acceleration for text, bitblts, transparent blts and fills.
- Up to 64 x 64 bit graphics hardware cursor.
- Up to 4MB long linear frame buffer.
- 8-, 16-, and 24-bit pixels.

### ■ CRT Controller

- Integrated 135MHz triple RAMDAC allowing for 1024 x 768 x 75Hz display.
- 8-, 16-, 24-bit pixels.
- Interlaced or non-interlaced output.

### ■ Video Input port

- Accepts video inputs in CCIR 601 mode.
- Optional 2:1 decimator
- Stores captured video in off setting area of the onboard frame buffer.
- Video pass through to the onchip PAL/NTSC encoder for full screen video images.
- HSYNC and B/T generation or lock onto external video timing source.

### ■ Video Pipeline

- Two-tap interpolative horizontal filter.
- Two-tap interpolative vertical filter.
- Color space conversion.
- Programmable window size.
- Chroma and color keying for integrated video overlay.

### ■ TV Output

- Programmable two tap filter with gamma correction or three tap flicker filter.
- Progressive to interlaced scan converter.
- NTSC-M, PAL-M, PAL-B,D,G,H,I, PAL-N easy programmable video outputs.
- CCIR601 encoding with programmable color subcarrier frequencies.
- Line skip/insert capability
- Interlaced or non-interlaced operation mode.
- 625 lines/50Hz or 525 lines/60Hz 8 bit multiplexed CB-Y-CR digital input.
- CVBS and R,G,B simultaneous analog outputs through 10-bit DACs.
- Cross color reduction by specific trap filtering on luma within CVBS flow.
- Power down mode available on each DAC.

**■ PCI Controller**

- Fully compliant with PCI 2.1 specification.
- Integrated PCI arbitration interface. Up to 3 masters can connect directly. External PAL allows for greater than 3 masters.
- Translation of PCI cycles to ISA bus.
- Translation of ISA master initiated cycle to PCI.
- Support for burst read/write from PCI master.
- PCI clock is 1/3 or 1/2 Host clock .

**■ ISA master/slave controller**

- Generates the ISA clock from either 14.318MHz oscillator clock or PCI clock
- Supports programmable extra wait state for ISA cycles
- Supports I/O recovery time for back to back I/O cycles.
- Fast Gate A20 and Fast reset.
- Supports the single ROM that C, D, or E. blocks shares with F block BIOS ROM.
- Supports flash ROM.
- Supports ISA hidden refresh.
- Buffered DMA & ISA master cycles to reduce bandwidth utilization of the PCI and Host bus. NSP compliant.

**■ Integrated Peripheral Controller**

- 2X8237/AT compatible 7-channel DMA controller.
- 2X8259/AT compatible interrupt Controller. 16 interrupt inputs - ISA and PCI.
- Three 8254 compatible Timer/Counters.
- Co-processor error support logic.
- Supports external RTC.

**■ Local Bus interface**

- Multiplexed with ISA interface.
- Low latency bus
- 22-bit address bus.
- 16-bit data bus with word steering capability.
- Programmable timing (Host clock granularity)
- 2 Programmable Flash Chip Select.
- 4 Programmable I/O Chip Select.
- Supports 32-bit Flash burst.
- 2-level hardware key protection for Flash boot block protection.
- Supports 2 banks of 8MB flash devices with boot block shadowed to 0x000F0000.

**■ IDE Interface**

- Supports PIO and Bus Master IDE
- Supports up to Mode 5 Timings
- Transfer Rates to 22 MBytes/sec
- Supports up to 4 IDE devices
- Concurrent channel operation (PIO & DMA modes) - 4 x 32-Bit Buffer FIFO per channel
- Support for PIO mode 3 & 4.
- Support for DMA mode 1 & 2.
- Bus Master with scatter/gather capability
- Multi-word DMA support for fast IDE drives
- Individual drive timing for all four IDE devices
- Supports both legacy & native IDE modes
- Supports hard drives larger than 528MB
- Support for CD-ROM and tape peripherals
- Backward compatibility with IDE (ATA-1).

**■ Power Management**

- Four power saving modes: On, Doze, Standby, Suspend.
- Programmable system activity detector
- Supports SMM.
- Supports STOPCLK.
- Supports IO trap & restart.
- Independent peripheral time-out timer to monitor hard disk, serial & parallel ports.
- Supports RTC, interrupts and DMAs wake-up

### 1 GENERAL DESCRIPTION

At the heart of the STPC Consumer-S is an advanced 64-bit processor block, dubbed the 5ST86. The 5ST86 includes a 5th generation processor core along with a 64-bit SDRAM controller, advanced 64-bit accelerated graphics and video controller, a high speed PCI local-bus controller and Industry standard PC chip set functions (Interrupt controller, DMA Controller, Interval timer and ISA bus).

The STPC Consumer-S makes use of a tightly coupled Unified Memory Architecture (UMA), where the same memory array is used for CPU main memory and graphics frame-buffer. This means a reduction in total system memory for system performances that are equal to that of a comparable Frame Buffer and system memory based system, and generally much better, due to the higher memory bandwidth allowed by attaching the graphics engine directly to the 64-bit processor host interface running at the speed of the processor bus rather than the traditional PCI bus.

The 64-bit wide memory array provides the system with 528MB/s peak bandwidth. This allows for higher resolution screens and greater color depth.

The 'standard' PC chipset functions (DMA, interrupt controller, timers, power management logic) are integrated together with the x86 processor core; additional functions such as communications ports are accessed by the STPC Consumer-S via internal ISA bus.

The PCI bus is the main data communication link to the STPC Consumer-S chip. The STPC Consumer-S translates appropriate host bus I/O and Memory cycles onto the PCI bus. It also supports generation of Configuration cycles on the PCI bus. The STPC Consumer-S, as a PCI bus agent (host bridge class), fully complies with PCI specification 2.1. The chip-set also implements the PCI mandatory header registers in Type 0 PCI configuration space for easy porting of PCI aware system BIOS. The device contains a PCI arbitration function for three external PCI devices.

The STPC Consumer-S has two functional blocks **sharing the same balls** : The ISA / IPC / IDE block and the Local Bus / IDE block (see [Table 2-1](#) & [Table 2-4](#)). Any board with the STPC Consumer-S should be built using only one of these two configurations.

At reset, the configuration is done by 'strap options' which initialises the STPC Consumer-S to the right settings. It is a set of pull-up or pull-down

resistors on the memory data bus, checked on reset, which auto-configure the STPC Consumer-S.

### GRAPHICS FUNCTIONS

Graphics functions are controlled through the on-chip SVGA controller and the monitor display is produced through the 2D graphics display engine.

This Graphics Engine is tuned to work with the host CPU to provide a balanced graphics system with a low silicon area cost. It performs limited graphics drawing operations which include hardware acceleration of text, bitblts, transparent blts and fills. The results of these operations change the contents of the on-screen or off-screen Frame Buffer areas of DRAM memory. The Frame Buffer can occupy a space up to 4 Mbytes anywhere in the physical main memory and always starts from the bottom of the main physical memory.

The graphics resolution supported is a maximum of 1280x1024 in 65536 colours and 1024x768 in true color at 75Hz refresh rate and is VGA and SVGA compatible. Horizontal timing fields are VGA compatible while the vertical fields are extended by one bit to accommodate above display resolution.

### VIDEO FUNCTIONS

The STPC Consumer-S provides several additional functions to handle MPEG or similar video streams. The Video Input Port accepts an encoded digital video stream in one of a number of industry standard formats, decodes it, optionally decimates it, and deposits it into an off screen area of the Frame Buffer. An interrupt request can be generated when an entire field or frame has been captured. The video output pipeline incorporates a video-scaler and color space converter function and provisions in the CRT controller to display a video window. While repainting the screen the CRT controller fetches both the video as well as the normal non-video Frame Buffer in two separate internal FIFOs. The video stream can be color-space converted (optionally) and smooth scaled. Smooth interpolative scaling in both horizontal and vertical direction are implemented. Color and Chroma key functions are also implemented to allow mixing video stream with non-video Frame Buffer.

The video output passes directly to the RAMDAC for monitor output or through another optional color space converter (RGB to 4:2:2 YCrCb) to the programmable anti-flicker filter. The flicker filter is

configured as either a two line filter with gamma correction (primarily designed for DOS type text) or a 3 line flicker filter (primarily designed for Windows type displays). The flicker filter is optional and can be software disabled for use with large screen area's of video.

The Video output pipeline of the STPC Consumer-S interfaces directly to the internal digital TV encoder. It takes a 24 bit RGB non-interlaced pixel stream and converts to a multiplexed 4:2:2 YCrCb 8 bit output stream, the logic includes a progressive to interlaced scan converter and logic to insert appropriate CCIR656 timing reference codes into the output stream. It facilitates the high quality display of VGA or full screen video streams received via the Video input port to standard NTSC or PAL televisions.

The digital PAL/NTSC encoder outputs interlaced or non-interlaced video in PAL-B,D,G,H,I PAL-N, PAL-M or NTSC-M standards and "NTSC- 4.43" is also possible.

The four frame (for PAL) or 2 frame (for NTSC) burst sequences are internally generated, subcarrier generation being performed numerically with CKREF as reference. Rise and fall times of synchronisation tips and burst envelope are internally controlled according to the relevant ITU-R and SMPTE recommendations.

Video output signals are directed to four analog output pins through internal D/A converters giving, simultaneous R,G,B and composite CVBS and S-VHS outputs.

## MEMORY CONTROLLER

The STPC handles the memory data (DATA) bus directly, controlling from 2 to 128 MBytes. The SDRAM controller supports accesses to the Memory Banks to/from the CPU (via the host), from the VIP, to/from the CRTC, to the VIDEO & to/from the GE. (Banks 0 to 3) which can be populated with either single or double sided 72-bit (4 bit parity) DIMMs. Parity is not supported.

The SDRAM controller only supports 64 bit wide Memory Banks.

Four Memory Banks (if DIMMS are used; Single sided or two double-sided DIMMs) are supported in the following configurations (see [Table 1-1](#)):

**Table 1-1. Supported Memory Configs**

Memory Bank size	Number	Organisation	Device size
1Mx64	4	1Mx16	16Mbit
2Mx64	8	2Mx8	
4Mx64	16	4Mx4	

The SDRAM Controller supports buffered or unbuffered SDRAM but not EDO or FPM modes. SDRAMs must support Full Page Mode Type access.

The STPC Memory Controller provides various programmable SDRAM parameters to allow the SDRAM interface to be optimized for different processor bus speeds SDRAM speed grades and CAS Latency.

## IDE INTERFACE

An industry standard EIDE (ATA 2) controller is built into the STPC Consumer-S. The IDE port is capable of supporting a total of four devices.

## POWER MANAGEMENT

The STPC Consumer-S core is compliant with the Advanced Power Management (APM) specification to provide a standard method by which the BIOS can control the power used by personal computers. The Power Management Unit module (PMU) controls the power consumption providing a comprehensive set of features that control the power usage and supports compliance with the United States Environmental Protection Agency's Energy Star Computer Program. The PMU provides following hardware structures to assist the software in managing the power consumption by the system.

- System Activity Detection.
- Three power down timers.
- Doze timer for detecting lack of system activity for short durations.
- Stand-by timer for detecting lack of system activity for medium durations
- Suspend timer for detecting lack of system activity for long durations.
- House-keeping activity detection.
- House-keeping timer to cope with short bursts of house-keeping activity while dozing or in stand-by

## GENERAL DESCRIPTION

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state.

- Peripheral activity detection.
- Peripheral timer for detecting lack of peripheral activity
- SUSP# modulation to adjust the system performance in various power down states of the system including full power on state.
- Power control outputs to disable power from different planes of the board.

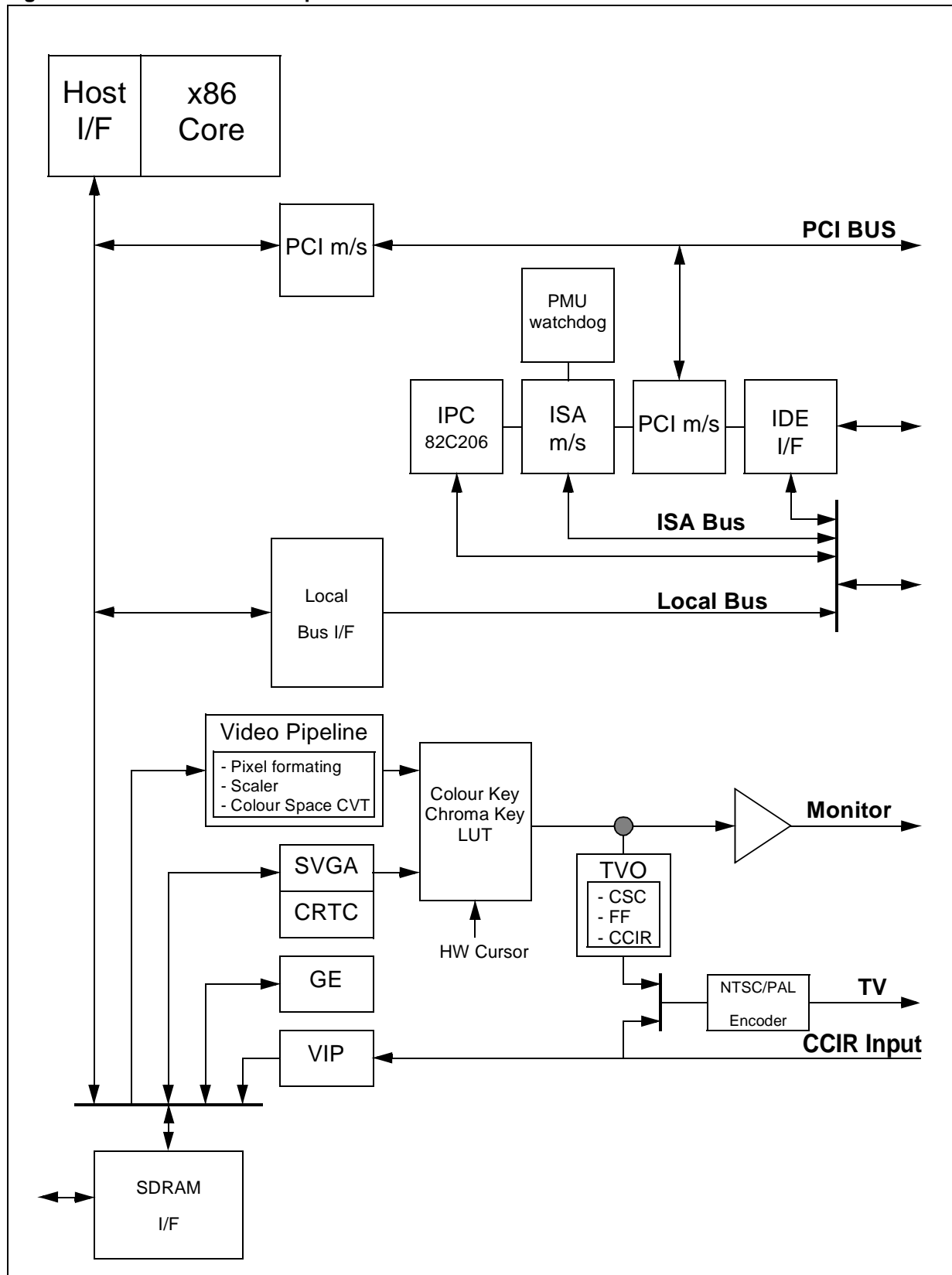
Lack of system activity for progressively longer period of times is detected by the three power down timers. These timers can generate SMI interrupts to CPU so that the SMM software can put the system in decreasing states of power consumption. Alternatively, system activity in a power down state can generate SMI interrupt to allow the software to bring the system back up to full power

on state. The chip-set supports up to three power down states: Doze state, Stand-by state and Suspend mode. These correspond to decreasing levels of power savings.

### POWER DOWN

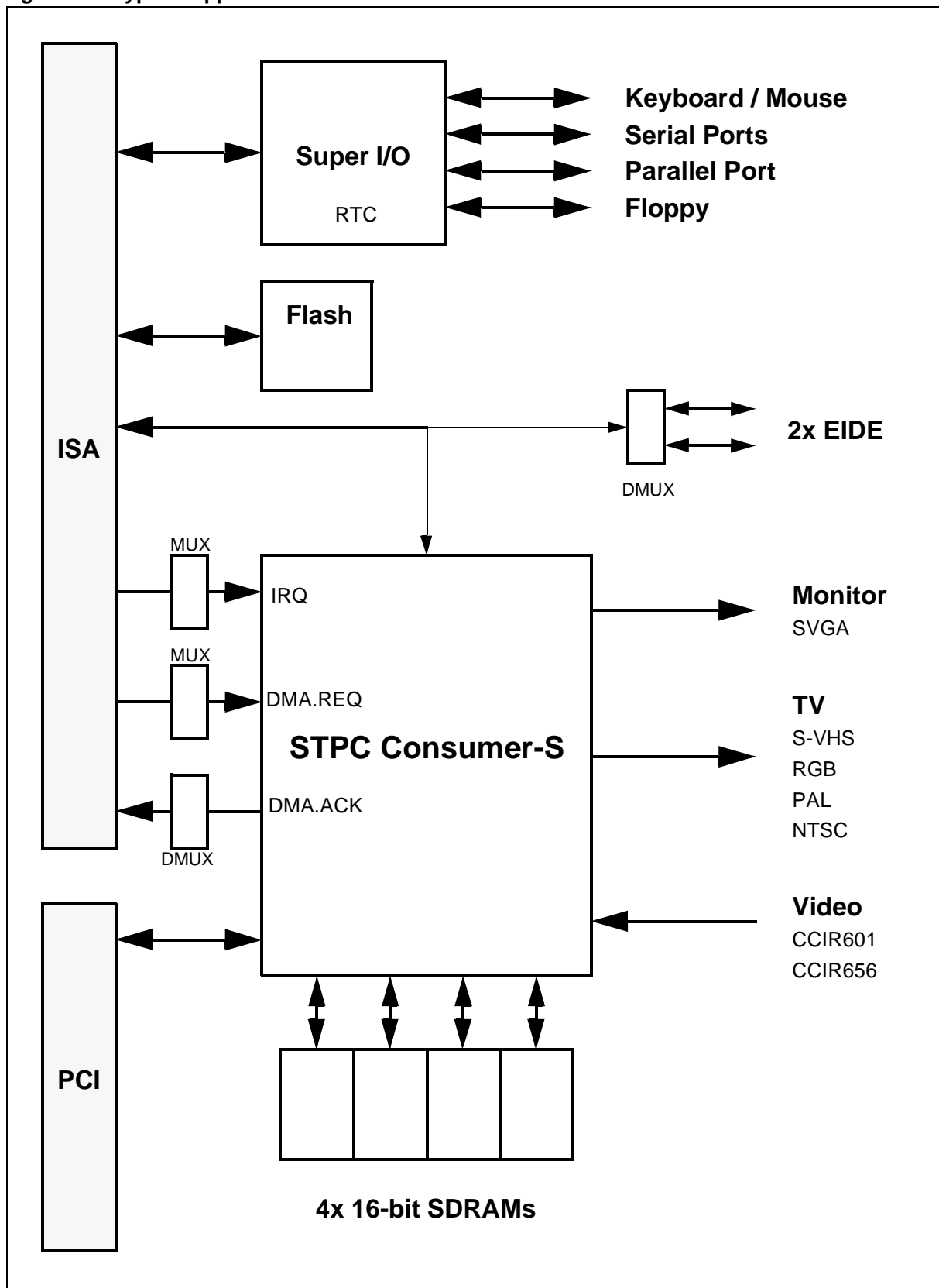
Power down puts the STPC Consumer-S into suspend mode. The processor completes execution of the current instruction, any pending decoded instructions and associated bus cycles. During the suspend mode, internal clocks are stopped. Removing power down, the processor resumes instruction fetching and begins execution in the instruction stream at the point it had stopped. Because of the static nature of the core, no internal data is lost.

Figure 1-1. .Functionnal description.



## GENERAL DESCRIPTION

Figure 1-2. Typical Application





## 2 PIN DESCRIPTION

### 2.1 INTRODUCTION

The STPC Consumer-S integrates most of the functionalities of the PC architecture. As a result, many of the traditional interconnections between the host PC microprocessor and the peripheral devices are totally internal to the STPC Consumer-S. This offers improved performance due to the tight coupling of the processor core and these peripherals. As a result many of the external pin connections are made directly to the on-chip peripheral functions.

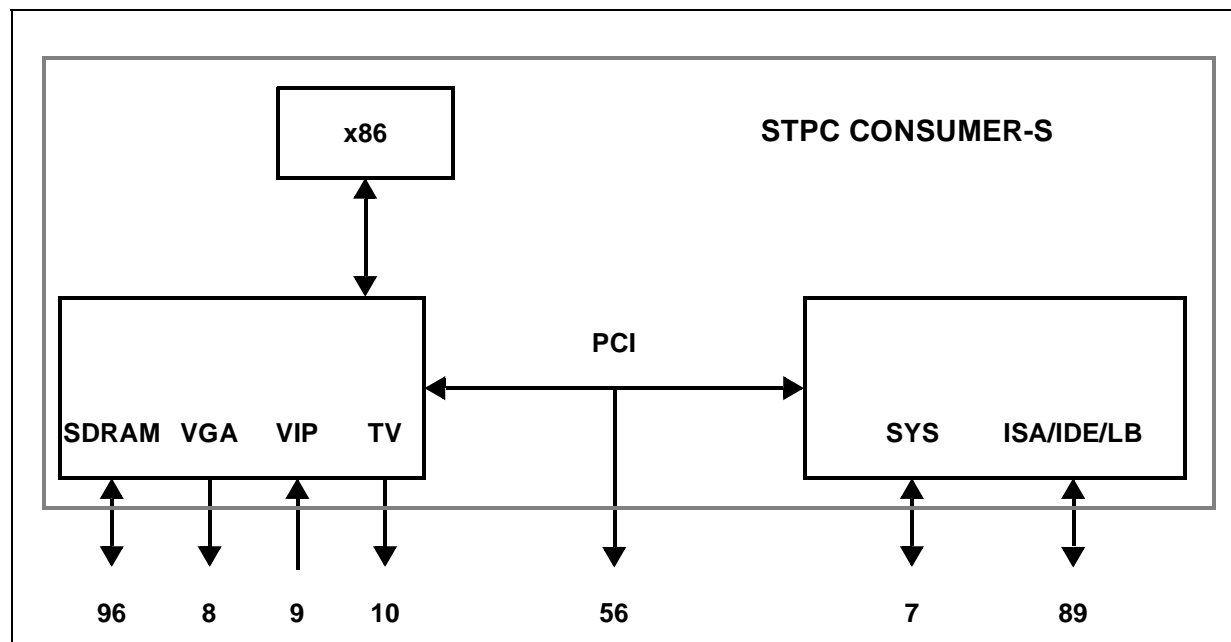
Figure 2-1 shows the STPC Consumer-S external interfaces. It defines the main busses and their function. Table 2-1 describes the physical implementation listing signals type and their functionality. Table 2-2 provides a full pin listing and description of pins. Table 2-5 provides a full listing of pin locations of the STPC Consumer-S package by physical connection.

**Table 2-1. Signal Description**

Group name	Qty
System Clocks & Resets (SYS)	7
SDRAM Controler	95
PCI interface	56
ISA Interface	79
IDE Controller	34
Local Bus	49
Video Input	9
TV Output	10
VGA Monitor interface	8
Grounds	74
V <sub>DD</sub>	29
Miscellaneous	4
Unconnected	7
Total Pin Count	388

**Note:** Several interface pins are multiplexed with other functions, refer to Table 2-3 and Table 2-4 for further details

**Figure 2-1. STPC Consumer-S External Interfaces**



## PIN DESCRIPTION

**Table 2-2. Definition of Signal Pins**

Signal Name	Dir	Description	Qty
<b>BASIC CLOCKS AND RESETS</b>			
SYSRSTI# <sup>2</sup>	I	System Power Good Input	1
SYSRSTO# <sup>2</sup>	O	System Reset Output	1
XTALI	I	14.3MHz Crystal Input	1
XTALO	I/O	14.3MHz Crystal Output - External Oscillator Input	1
HCLK <sup>2</sup>	I/O	Host Clock (Test)	1
DEV_CLK	O	24MHz Peripheral Clock (floppy drive)	1
DCLK <sup>2</sup>	I/O	27-135MHz Graphics Dot Clock	1
V <sub>DD</sub> _xxx_PLL <sup>1</sup>		Power Supply for PLL Clocks	
<b>MEMORY INTERFACE</b>			
MCLKI	I	Memory Clock Input	1
MCLKO	O	Memory Clock Output	1
CS#[3:0]	O	Memory Bank Chip Select	4
BA[0]	O	Memory Row & Column Address/Bank Address	1
MA[10:0]	O	Memory Row & Column Address	11
MD[63:0] <sup>2</sup>	I/O	Memory Data	64
RAS#[1:0]	O	Row Address Strobe	2
CAS#[1:0]	O	Column Address Strobe	2
MWE#	O	Write Enable	1
DQM[7:0]	O	Data Input/Output Mask	8
<b>PCI INTERFACE</b>			
PCI_CLKI <sup>2</sup>	I	33MHz PCI Input Clock	1
PCI_CLKO	O	33MHz PCI Output Clock (from internal PLL)	1
AD[31:0] <sup>2</sup>	I/O	PCI Address / Data	32
CBE#[3:0] <sup>2</sup>	I/O	Bus Commands / Byte Enables	4
FRAME# <sup>2</sup>	I/O	Cycle Frame	1
IRDY# <sup>2</sup>	I/O	Initiator Ready	1
TRDY# <sup>2</sup>	I/O	Target Ready	1
LOCK# <sup>2</sup>	I	PCI Lock	1
DEVSEL# <sup>2</sup>	I/O	Device Select	1
STOP# <sup>2</sup>	I/O	Stop Transaction	1
PAR <sup>2</sup>	I/O	Parity Signal Transactions	1
SERR# <sup>2</sup>	O	System Error	1
PCI_REQ#[2:0] <sup>2</sup>	I	PCI Request	3
PCI_GNT#[2:0] <sup>2</sup>	O	PCI Grant	3
PCI_INT[3:0] <sup>2</sup>	I	PCI Interrupt Request	4
VDD5	I	5V Power Supply for PCI ESD protection	4
<b>ISA CONTROL</b>			
ISA_CLK <sup>2</sup>	O	ISA Clock Output - Multiplexer Select Line For IPC	1
ISA_CLK2X <sup>2</sup>	O	ISA Clock x2 Output - Multiplexer Select Line For IPC	1
OSC14M <sup>2</sup>	O	ISA bus synchronisation clock	1
LA[23:17] <sup>2</sup>	O	Unlatched Address	7
<p>Note<sup>1</sup>; These pins must be connected to the 2.5V power supply. They <b>must not</b> be connected to the 3.45V supply.</p> <p>Note<sup>2</sup>; Denotes that the pin is V<sub>5T</sub> (see <a href="#">Section 4</a> )</p> <p>Note<sup>3</sup>; see <a href="#">Table 2-5</a> for the detail of individual V<sub>5T</sub> signals</p>			

Table 2-2. Definition of Signal Pins

Signal Name	Dir	Description	Qty
SA[19:0]	I/O	Latched Address	20
SD[15:0] <sup>2</sup>	I/O	Data Bus	16
ALE <sup>2</sup>	O	Address Latch Enable	1
MEMR# <sup>2</sup> , MEMW# <sup>2</sup>	I/O	Memory Read and Memory Write	2
SMEMR# <sup>2</sup> , SMEMW# <sup>2</sup>	O	System Memory Read and Memory Write	2
IOR# <sup>2</sup> , IOW# <sup>2</sup>	I/O	I/O Read and Write	2
MCS16# <sup>2</sup> , IOCS16# <sup>2</sup>	I	Memory/IO Chip Select16	2
BHE# <sup>2</sup>	O	System Bus High Enable	1
ZWS# <sup>2</sup>	I	Zero Wait State	1
REF# <sup>2</sup>	O	Refresh Cycle.	1
MASTER# <sup>2</sup>	I	Add On Card Owns Bus	1
AEN <sup>2</sup>	O	Address Enable	1
IOCHCK# <sup>2</sup>	I	I/O Channel Check.	1
IOCHRDY <sup>2</sup>	I/O	I/O Channel Ready (ISA) - Busy/Ready (IDE)	1
ISAOE# <sup>2</sup>	O	ISA/IDE Selection	1
GPIOCS# <sup>2</sup>	I/O	General Purpose Chip Select	1
IRQ_MUX[3:0] <sup>2</sup>	I	Time-Multiplexed Interrupt Request	4
DREQ_MUX[1:0] <sup>2</sup>	I	Time-Multiplexed DMA Request	2
DACK_ENC[2:0] <sup>2</sup>	O	Encoded DMA Acknowledge	3
TC <sup>2</sup>	O	ISA Terminal Count	1
RTCAS# <sup>2</sup>	O	Real Time Clock Address Strobe	1
RMRTCCS# <sup>2</sup>	I/O	ROM/RTC Chip Select	1
KBCS# <sup>2</sup>	I/O	Keyboard Chip Select	1
RTCRW# <sup>2</sup>	I/O	RTC Read/Write	1
RTCDS# <sup>2</sup>	I/O	RTC Data Strobe	1
<b>LOCAL BUS</b>			
PA[21:0]	O	Address Bus	22
PD[15:0]	I/O	Data Bus	16
PRD1#, PRD0#	O	Peripheral Read Control	2
PWR1#, PWR0#	O	Peripheral Write Control	2
PRDY#	I	Data Ready	1
FCS1#, FCS0#	O	Flash Chip Select	2
IOCS#[3:0]	O	I/O Chip Select	4
<b>IDE CONTROL</b>			
DA[2:0]	O	Address Bus	3
DD[15:0]	I/O	Data Bus	16
PCS3#, PCS1#, SCS3#, SCS1#	O	Primary & Secondary Chip Selects	4
DIORDY	O	Data I/O Ready	1
PIRQ <sup>2</sup> , SIRQ <sup>2</sup>	I	Primary & Secondary Interrupt Request	2
PDRQ <sup>2</sup> , SDRQ <sup>2</sup>	I	Primary & Secondary DMA Request	2
PDAK# <sup>2</sup> , SDAK# <sup>2</sup>	O	Primary & Secondary DMA Acknowledge	2
PDIOR# <sup>2</sup> , SDIOR# <sup>2</sup>	O	Primary & Secondary I/O Channel Read	2
PDIOW# <sup>2</sup> , SDIOW# <sup>2</sup>	O	Primary & Secondary I/O Channel Write	2
Note <sup>1</sup> : These pins must be connected to the 2.5V power supply. They <b>must not</b> be connected to the 3.45V supply.			
Note <sup>2</sup> : Denotes that the pin is V <sub>5T</sub> (see <a href="#">Section 4</a> )			
Note <sup>3</sup> : see <a href="#">Table 2-5</a> for the detail of individual V <sub>5T</sub> signals			

## PIN DESCRIPTION

**Table 2-2. Definition of Signal Pins**

Signal Name	Dir	Description	Qty
<b>MONITOR INTERFACE</b>			
RED, GREEN, BLUE	O	Analog Red, Green, Blue	3
VSYNC <sup>2</sup>	O	Vertical Sync	1
HSYNC <sup>2</sup>	O	Horizontal Sync	1
VREF_DAC	I	DAC Voltage reference	1
RSET	I	Resistor Set	1
COMP	I	Compensation	1
<b>VIDEO INPUT</b>			
VCLK <sup>2</sup>	I	27-33MHz Video Input Port Clock	1
VIN[7:0] <sup>2</sup>	I	CCIR 601 or 656 YUV Video Data Input	8
<b>ANALOG TV OUTPUT</b>			
RED_TV <sup>2</sup> , GREEN_TV <sup>2</sup> , BLUE_TV <sup>2</sup>	O	Analog RGB or S-VHS outputs	3
CVBS <sup>2</sup>	O	Analog video composite output	1
IREF1_TV	I	Reference current of 9bit DAC for CVBS	1
VREF1_TV	I	Reference voltage of 9bit DAC for CVBS	1
IREF2_TV <sup>2</sup>	I	Reference current of 8bit DAC for R,G,B	1
VREF2_TV <sup>2</sup>	I	Reference voltage of 8bit DAC for R,G,B	1
VSSA_TV	I	Analog Vss for DAC	1
VDDA_TV	I	Analog Vdd for DAC	1
VCS <sup>2</sup>	I/O	Composite Synch or Horizontal line SYNC output	1
ODD_EVEN <sup>2</sup>	I/O	Frame Synchronisation	1
<b>MISCELLANEOUS</b>			
SPKRD <sup>2</sup>	O	Speaker Device Output	1
SCL <sup>2</sup>	I/O	I <sup>2</sup> C Interface - Clock / Can be used for VGA DDC[1] signal	1
SDA <sup>2</sup>	I/O	I <sup>2</sup> C Interface - Data / Can be used for VGA DDC[0] signal	1
SCAN_ENABLE <sup>2</sup>	I	Reserved (Test pin)	1
<p>Note<sup>1</sup>; These pins must be connected to the 2.5Vpower supply. They <b>must not</b> be connected to the 3.45V supply.</p> <p>Note<sup>2</sup>; Denotes that the pin is V<sub>5T</sub> (see <a href="#">Section 4</a> )</p> <p>Note<sup>3</sup>; see <a href="#">Table 2-5</a> for the detail of individual V<sub>5T</sub> signals</p>			

## 2.2 SIGNAL DESCRIPTIONS

### 2.2.1 BASIC CLOCKS AND RESETS

**SYSRSTI#** *System Reset/Power good.* This input is low when the reset switch is depressed. Otherwise, it reflects the power supply's power good signal. This input is asynchronous to all clocks, and acts as a negative active reset. The reset circuit initiates a hard reset on the rising edge of this signal.

**SYSRSTO#** *Reset Output to System.* This is the system reset signal and is used to reset the rest of the components (not on Host bus) in the system. The ISA bus reset is an externally inverted buffered version of this output and the PCI bus reset is an externally buffered version of this output.

**XTALI** *14.3MHz Crystal Input*

**XTALO** *14.3MHz Crystal Output.* These pins are connected to the 14.318 MHz crystal to provide the reference clock for the internal frequency synthesizer to generate all the other clocks.

A 14.318 MHz Series Cut Crystal should be connected between these two pins. Balance capacitors of 15 pF should also be added. In the event of an external quartz oscillator providing the master clock signal to the STPC Consumer-S device, the TTL signal should be provided on XTALO.

**HCLK** *Host Clock.* This clock supplies the CPU and the host related blocks. This clock can be doubled inside the CPU and is intended to operate in the range of 25 to 100 MHz. This clock is generated internally from a PLL but can be driven directly from the external system.

**DEV\_CLK** *24MHz Peripheral Clock.* This 24MHz signal is provided as a convenience for the system integration of a Floppy Disk driver function in an external chip.

**DCLK** *135MHz Dot Clock.* This is the Dot clock, which drives graphics display cycles. Its frequency can go from 8MHz (using internal PLL) up to 135 MHz, and it is required to have a worst case duty cycle of 60-40.

This signal is either driven by the internal pll (VGA) or an external 27MHz oscillator (when the composite video output is enabled). The direction can be controlled by a strap option or an internal register bit.

### 2.2.2 MEMORY INTERFACE

**MCLKI** *Memory Clock Input.* This clock is driving the SDRAM controller, the graphics engine and

display controller. This input should be a buffered version of the MCLKO signal with the track lengths between the buffer and the pin matched with the track lengths between the buffer and the Memory Banks.

**MCLKO** *Memory Clock Output.* This clock drives the Memory Banks on board and is generated from an internal PLL. The default value is 80MHz.

**CS#[3:0]** *Chip Select* These signals are used to disable or enable device operation by masking or enabling all SDRAM inputs except MCLK, CKE, and DQM.

**BA[0]** *Memory Bank Address.*

**MA[10:0]** *Memory Address.* Multiplexed row and column address lines.

**MD[63:0]** *Memory Data.* This is the 64-bit memory data bus. MD[40:0] are read by the device strap option registers during rising edge of SYSRSTI#.

**RAS#[1:0]** *Row Address Strobe.* These signals enable row access and precharge. Row address is latched on rising edge of MCLK when RAS# is low.

**CAS#[1:0]** *Column Address Strobe.* These signals enable column access. Column address is latched on rising edge of MCLK when CAS# is low.

**MWE#** *Write Enable.* Write enable specifies whether the memory access is a read (MWE# = H) or a write (MWE# = L).

**DQM#[7:0]** *Data Mask.* Makes data output Hi-Z after the clock and masks the SDRAM outputs. It blocks SDRAM data input when DQM active.

### 2.2.3 PCI INTERFACE

**PCI\_CLKI** *33MHz PCI Input Clock.* This signal is the PCI bus clock input and should be driven from the PCI\_CLKO pin.

**PCI\_CLKO** *33MHz PCI Output Clock.* This is the master PCI bus clock output.

**AD[31:0]** *PCI Address/Data.* This is the 32-bit multiplexed address and data bus of the PCI. This bus is driven by the master during the address phase and data phase of write transactions. It is driven by the target during data phase of read transactions. Signals AD[12:11] for internal use only. Not to be used for External PCI devices.

## PIN DESCRIPTION

**CBE#[3:0]** *Bus Commands/Byte Enables.* These are the multiplexed command and byte enable signals of the PCI bus. During the address phase they define the command and during the data phase they carry the byte enable information. These pins are inputs when a PCI master other than the STPC Consumer-S owns the bus and outputs when the STPC Consumer-S owns the bus.

**FRAME#** *Cycle Frame.* This is the frame signal of the PCI bus. It is an input when a PCI master owns the bus and is an output when STPC Consumer-S owns the PCI bus.

**IRDY#** *Initiator Ready.* This is the initiator ready signal of the PCI bus. It is used as an output when the STPC Consumer-S initiates a bus cycle on the PCI bus. It is used as an input during the PCI cycles targeted to the STPC Consumer-S to determine when the current PCI master is ready to complete the current transaction.

**TRDY#** *Target Ready.* This is the target ready signal of the PCI bus. It is driven as an output when the STPC Consumer-S is the target of the current bus transaction. It is used as an input when STPC Consumer-S initiates a cycle on the PCI bus.

**LOCK#** *PCI Lock.* This is the lock signal of the PCI bus and is used to implement the exclusive bus operations when acting as a PCI target agent.

**DEVSEL#** *I/O Device Select.* This signal is used as an input when the STPC Consumer-S initiates a bus cycle on the PCI bus to determine if a PCI slave device has decoded itself to be the target of the current transaction. It is asserted as an output either when the STPC Consumer-S is the target of the current PCI transaction or when no other device asserts DEVSEL# prior to the subtractive decode phase of the current PCI transaction.

**STOP#** *Stop Transaction.* Stop is used to implement the disconnect, retry and abort protocol of the PCI bus. It is used as an input for the bus cycles initiated by the STPC Consumer-S and is used as an output when a PCI master cycle is targeted to the STPC Consumer-S.

**PAR** *Parity Signal Transactions.* This is the parity signal of the PCI bus. This signal is used to guarantee even parity across AD[31:0], CBE#[3:0], and PAR. This signal is driven by the master during the address phase and data phase of write transactions. It is driven by the target during data phase of read transactions. (Its assertion is identical to that of the AD bus delayed by one PCI clock cycle)

**SERR#** *System Error.* This is the system error signal of the PCI bus. It may, if enabled, be asserted for one PCI clock cycle if target aborts a STPC Consumer-S initiated PCI transaction. Its assertion by either the STPC Consumer-S or by another PCI bus agent will trigger the assertion of NMI to the host CPU. This is an open drain output.

**PCI\_REQ#[2:0]** *PCI Request.* This pin are the three external PCI master request pins. They indicates to the PCI arbiter that the external agents desire use of the bus.

**PCI\_GNT#[2:0]** *PCI Grant.* These pins indicate that the PCI bus has been granted to the master requesting it on its PCI\_REQ#.

**PCI\_INT[3:0]** *PCI Interrupt Request.* These are the PCI bus interrupt signals.

**VDD5** *5V Power Supply.* These power pins are necessary for 5V ESD protection. In case the PCI bus is used in 3.45V only, these pins can be connected to 3.45V.

### 2.2.4 ISA INTERFACE

**ISA\_CLK, ISA\_CLKX2** *ISA Clock x1, x2.* These pins generate the Clock signal for the ISA bus and a Doubled Clock signal. They are also used as the multiplexor control lines for the Interrupt Controller Interrupt input lines. ISA\_CLK is generated from either PCICLK/4 or OSC14M/ 2.

**OSC14M** *ISA bus synchronisation clock Output.* This is the buffered 14.318 Mhz clock for the ISA bus.

**LA[23:17]** *Unlatched Address.* When the ISA bus is active, these pins are ISA Bus unlatched address for 16-bit devices. When ISA bus is accessed by any cycle initiated from PCI bus, these pins are in output mode. When an ISA bus master owns the bus, these pins are in input mode.

**SA[19:0]** *ISA Address Bus.* System address bus of ISA on 8-bit slot. These pins are used as an input when an ISA bus master owns the bus and are outputs at all other times.

**SD[15:0]** *I/O Data Bus.* These pins are the external databus to the ISA bus.

**ALE** *Address Latch Enable.* This is the address latch enable output of the ISA bus and is asserted by the STPC Consumer-S to indicate that LA23-17, SA19-0, AEN and SBHE# signals are valid. The ALE is driven high during refresh, DMA mas-

ter or an ISA master cycles by the STPC Consumer-S. ALE is driven low after reset.

**MEMR#** *Memory Read*. This is the memory read command signal of the ISA bus. It is used as an input when an ISA master owns the bus and is an output at all other times.  
The MEMR# signal is active during refresh.

**MEMW#** *Memory Write*. This is the memory write command signal of the ISA bus. It is used as an input when an ISA master owns the bus and is an output at all other times.

**SMEMR#** *System Memory Read*. The STPC Consumer-S generates SMEMR# signal of the ISA bus only when the address is below one megabyte or the cycle is a refresh cycle.

**SMEMW#** *System Memory Write*. The STPC Consumer-S generates SMEMW# signal of the ISA bus only when the address is below one megabyte.

**IOR#** *I/O Read*. This is the IO read command signal of the ISA bus. It is an input when an ISA master owns the bus and is an output at all other times.

**IOW#** *I/O Write*. This is the IO write command signal of the ISA bus. It is an input when an ISA master owns the bus and is an output at all other times.

**MCS16#** *Memory Chip Select16*. This is the decode of LA23-17 address pins of the ISA address bus without any qualification of the command signal lines. MCS16# is always an input. The STPC Consumer-S ignores this signal during IO and refresh cycles.

**IOCS16#** *IO Chip Select16*. This signal is the decode of SA15-0 address pins of the ISA address bus without any qualification of the command signals. The STPC Consumer-S does not drive IOCS16# (similar to PC-AT design). An ISA master access to an internal register of the STPC Consumer-S is executed as an extended 8-bit IO cycle.

**BHE#** *System Bus High Enable*. This signal, when asserted, indicates that a data byte is being transferred on SD15-8 lines. It is used as an input when an ISA master owns the bus and is an output at all other times.

**ZWS#** *Zero Wait State*. This signal, when asserted by addressed device, indicates that current cycle can be shortened.

**REF#** *Refresh Cycle*. This is the refresh command signal of the ISA bus. It is driven as an output when the STPC Consumer-S performs a refresh cycle on the ISA bus. It is used as an input when an ISA master owns the bus and is used to trigger a refresh cycle.

The STPC Consumer-S performs a pseudo hidden refresh. It requests the host bus for two host clocks to drive the refresh address and capture it in external buffers. The host bus is then relinquished while the refresh cycle continues on the ISA bus.

**MASTER#** *Add On Card Owns Bus*. This signal is active when an ISA device has been granted bus ownership.

**AEN** *Address Enable*. Address Enable is enabled when the DMA controller is the bus owner to indicate that a DMA transfer will occur. The enabling of the signal indicates to IO devices to ignore the IOR#/IOW# signal during DMA transfers.

**IOCHCK#** *IO Channel Check*. IO Channel Check is enabled by any ISA device to signal an error condition that can not be corrected. NMI signal becomes active upon seeing IOCHCK# active if the corresponding bit in Port B is enabled.

**IOCHRDY** *Channel Ready*. IOCHRDY is the IO channel ready signal of the ISA bus and is driven as an output in response to an ISA master cycle targeted to the host bus or an internal register of the STPC Consumer-S. The STPC Consumer-S monitors this signal as an input when performing an ISA cycle on behalf of the host CPU, DMA master or refresh.

ISA masters which do not monitor IOCHRDY are not guaranteed to work with the STPC Consumer-S since the access to the system memory can be considerably delayed due UMA architecture.

**ISAOE#** *Bidirectional OE Control*. This signal controls the  $\overline{OE}$  signal of the external transceiver that connects the IDE DD bus and ISA SA bus.

**GPIOCS#** *I/O General Purpose Chip Select*. This output signal is used by the external latch on ISA bus to latch the data on the SD[7:0] bus. The latch can be use by PMU unit to control the external peripheral devices or any other desired function.

**IRQ\_MUX[3:0]** *Multiplexed Interrupt Request*. These are the ISA bus interrupt signals. They have to be encoded before connection to the STPC Consumer-S using ISACLK and ISACLKX2 as the input selection strobes.

Note that IRQ8B, which by convention is connected to the RTC, is inverted before being sent to the

## PIN DESCRIPTION

interrupt controller, so that it may be connected directly to the IRQ pin of the RTC.

**DREQ\_MUX[1:0]** *ISA Bus Multiplexed DMA Request.* These are the ISA bus DMA request signals. They are to be encoded before connection to the STPC Consumer-S using ISACLK and ISACLKX2 as the input selection strobes.

**DACK\_ENC[2:0]** *DMA Acknowledge.* These are the ISA bus DMA acknowledge signals. They are encoded by the STPC Consumer-S before output and should be decoded externally using ISACLK and ISACLKX2 as the control strobes.

**TC** *ISA Terminal Count.* This is the terminal count output of the DMA controller and is connected to the TC line of the ISA bus. It is asserted during the last DMA transfer, when the byte count expires.

### 2.2.5 X-Bus Interface pins

**RTCAS#** *Real time clock address strobe.* This signal is asserted for any I/O write to port 70H.

**RMRTCCS#** *ROM/Real Time clock chip select.* This signal is asserted if a ROM access is decoded during a memory cycle. It should be combined with MEMR# or MEMW# signals to properly access the ROM. During a IO cycle, this signal is asserted if access to the Real Time Clock (RTC) is decoded. It should be combined with IOR or IOW# signals to properly access the real time clock.

**KBCS#** *Keyboard Chip Select.* This signal is asserted if a keyboard access is decoded during a I/O cycle.

**RTCRW#** *Real Time Clock  $\overline{RW}$ .* This pin is a multi-function pin. When ISAOE# is active, this signal is used as RTCRW#. This signal is asserted for any I/O write to port 71H.

**RTCDS#** *Real Time Clock DS.* This pin is a multi-function pin. When ISAOE# is active, this signal is used as RTCDS. This signal is asserted for any I/O read to port 71H.

Note: RMRTCCS#, KBCS#, RTCRW# and RTCDS# signals must be ORed externally with ISAOE# and then connected to the external device. An LS244 or equivalent function can be used if OE# is connected to ISAOE# and the output is provided with a weak pull-up resistor as shown in [Figure 2-2](#).

### 2.2.6 LOCAL BUS

**PA[21:0]** *Address Bus Output.*

**PD[15:0]** *Data Bus.* This is the 16-bit data bus. D[7:0] is the LSB and PD[15:8] is the MSB.

**PRD#[1:0]** *Read Control output.* PRD0# is used to read the LSB and PRD1# to read the MSB.

**PWR#[1:0]** *Write Control output.* PWR0# is used to write the LSB and PWR1# to write the MSB.

**PRDY#** *Data Ready input.* This signal is used to create wait states on the bus. When HIGH it completes the cycle without any wait state added.

**FCS#[1:0]** *Flash Chip Select output.* These are the Programmable Chip Select signals for up to 2 banks of Flash memory.

**IOCS#[3:0]** *I/O Chip Select output.* These are the Programmable Chip Select signals for up to 4 external I/O devices.

### 2.2.7 IDE INTERFACE

**DA[2:0]** *Address.* These signals are connected to DA[2:0] of IDE devices directly or through a buffer. If the toggling of signals are to be masked during ISA bus cycles, they can be externally ORed with ISAOE# before being connected to the IDE devices.

**DD[15:0]** *Databus.* When the IDE bus is active, they serve as IDE signals DD[15:0]. IDE devices are connected to SA[19:8] directly and ISA bus is connected to these pins through two LS245 transceivers as described in [Figure 2-2](#).

**PCS1#, PCS3#** *Primary Chip Select.* These signals are used as the active high primary master & slave IDE chip select signals. These signals must be externally ANDed with the ISAOE# signal before driving the IDE devices to guarantee it is active only when ISA bus is idle.

**SCS1#, SCS3#** *Secondary Chip Select.* These signals are used as the active high secondary master & slave IDE chip select signals. These signals must be externally ANDed with the ISAOE# signal before driving the IDE devices to guarantee it is active only when ISA bus is idle.

**DIORDY** *Busy/Ready.* This pin serves as IDE signal DIORDY.

**PIRQ** *Primary Interrupt Request.*

**SIRQ** *Secondary Interrupt Request.*

Interrupt request from IDE channels.



**PDRQ** *Primary DMA Request.*  
**SDRQ** *Secondary DMA Request.*  
 DMA request from IDE channels.

**PDACK#** *Primary DMA Acknowledge.*  
**SDACK#** *Secondary DMA Acknowledge.*  
 DMA acknowledge to IDE channels.

**PDIOR#, PDIOW#** *Primary I/O Read & Write.*  
**SDIOR#, SDIOW#** *Secondary I/O Read & Write.*  
 Primary & Secondary channel read & write.

## 2.2.8 Monitor Interface

**RED, GREEN, BLUE** *RGB Video Outputs.* These are the 3 analog color outputs from the RAMDACs. These signals are sensitive to interference, therefore they need to be properly shielded.

**VSNC** *Vertical Synchronisation Pulse.* This is the vertical synchronization signal from the VGA controller.

**HSNC** *Horizontal Synchronisation Pulse.* This is the horizontal synchronization signal from the VGA controller.

**VREF\_DAC** *DAC Voltage reference.* An external voltage reference is connected to this pin to bias the DAC.

**RSET** *Resistor Current Set.* This reference current input to the RAMDAC is used to set the full-scale output of the RAMDAC.

**COMP** *Compensation.* This is the RAMDAC compensation pin. Normally, an external capacitor (typically 10nF) is connected between this pin and  $V_{DD}$  to damp oscillations.

## 2.2.9 VIDEO INPUT

**VCLK** *Pixel Clock Input.* This signal is used to synchronise data being transferred from an external video device to either the frame buffer, or alternatively out the TV output in bypass mode. This pin can be sourced from STPC if no external VCLK is detected, or can be input from an external video clock source.

**VIN[7:0]** *YUV Video Data Input CCIR 601 or 656.* Time multiplexed 4:2:2 luminance and chrominance data as defined in ITU-R Rec601-2 and Rec656 (except for TTL input levels). This bus typically carries a stream of Cb,Y,Cr,Y digital video at VCLK frequency, clocked on the rising edge (by default) of VCLK.

## 2.2.10 TV OUTPUT

**RED\_TV / C\_TV** *Analog video outputs synchronized with CVBS.* This output is current-driven and must be connected to analog ground over a load resistor ( $R_{LOAD}$ ). Following the load resistor, a simple analog low pass filter is recommended. In S-VHS mode, this is the Chrominance Output.

**GREEN\_TV / Y\_TV** *Analog video outputs synchronized with CVBS.* This output is current-driven and must be connected to analog ground over a load resistor ( $R_{LOAD}$ ). Following the load resistor, a simple analog low pass filter is recommended. In S-VHS mode, this is the Luminance Output.

**BLUE\_TV / CVBS** *Analog video outputs synchronized with CVBS.* This output is current-driven and must be connected to analog ground over a load resistor ( $R_{LOAD}$ ). Following the load resistor, a simple analog low pass filter is recommended. In S-VHS mode, this is a second composite output.

**CVBS** *Analog video composite output (luminance/chrominance).* CVBS is current-driven and must be connected to analog ground over a load resistor ( $R_{LOAD}$ ). Following the load resistor, a simple analog low pass filter is recommended.

**IREF1\_TV** *Ref. current* for CVBS 10-bit DAC.

**IREF2\_TV** *Reference current* for RGB 9-bit DAC.

**VREF1\_TV** *Ref. voltage* for CVBS 10-bit DAC.

**VREF2\_TV** *Reference voltage* for RGB 9-bit DAC.

**VSSA\_TV** *Analog  $V_{SS}$*  for DACs.

**VDDA\_TV** *Analog  $V_{DD}$*  for DACs.

**VCS** *Line synchronisation Output.* This pin is an input in ODDEV+HSYNC or VSYNC + HSYNC or VSYNC slave modes and an output in all other modes (master/slave)

**ODD\_EVEN** *Frame Synchronisation Output.* This pin supports the Frame synchronisation signal. It is an input in slave modes, except when sync is extracted from YCrCb data, and an output in master mode and when sync is extracted from YCrCb data

The signal is synchronous to rising edge of DCLK. The default polarity for this pin is:

- odd (not-top) field : LOW level
- even (bottom) field : HIGH level

## PIN DESCRIPTION

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### 2.2.11 MISCELLANEOUS

**SPKRD** *Speaker Drive*. This the output to the speaker and is AND of the counter 2 output with bit 1 of Port 61, and drives an external speaker driver. This output should be connected to 7407 type high voltage driver.

**SCL, SDA** I<sup>2</sup>C Interface. These bidirectional pins are connected to CRTC register 3Fh to implement

DDC capabilities. They conform to I<sup>2</sup>C electrical specifications, they have open-collector output drivers which are internally connected to V<sub>DD</sub> through pull-up resistors.

They can be used for the DDC1 (SCL) and DDC0 (SDA) lines of the VGA interface.

**SCAN\_ENABLE** *Reserved*. Must be connected to ground.

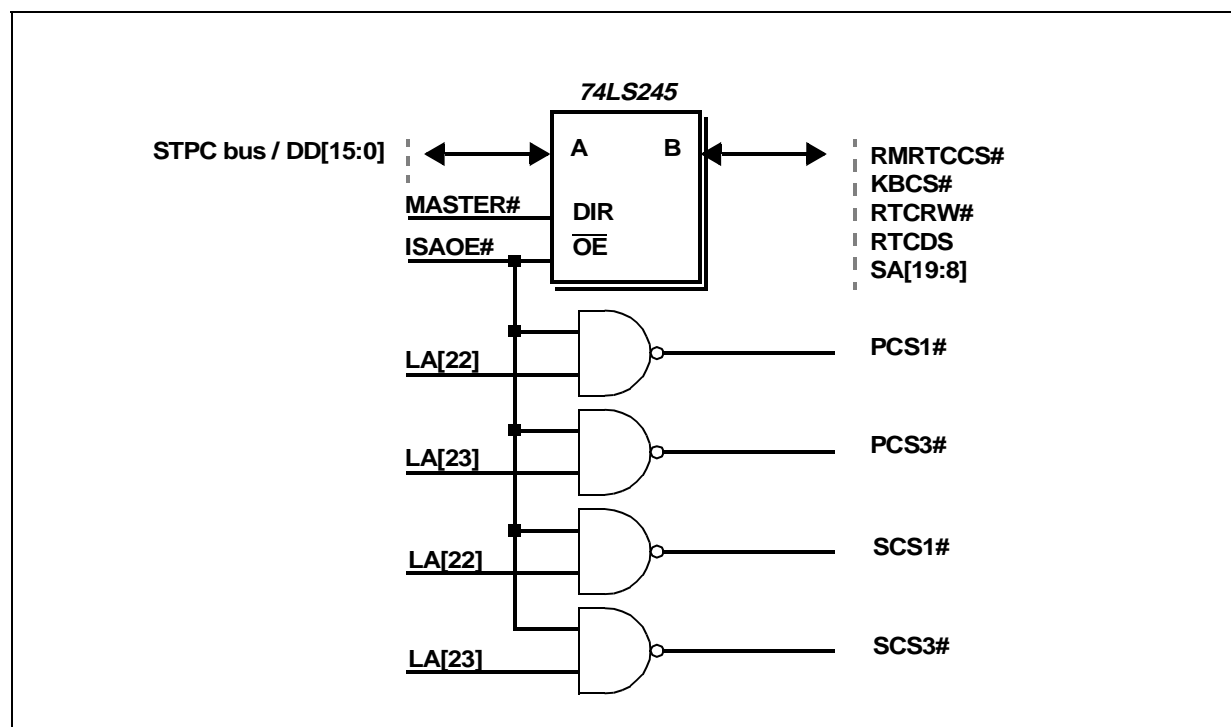
Table 2-3. ISA / IDE dynamic multiplexing

ISA BUS (ISAOE# = 0)	IDE (ISAOE# = 1)
RMRTCCS#	DD[15]
KBCS#	DD[14]
RTCRW#	DD[13]
RTCDS#	DD[12]
SA[19:8]	DD[11:0]
LA[23]	SCS3#
LA[22]	SCS1#
SA[21]	PCS3#
SA[20]	PCS1#
LA[19:17]	DA[2:0]
IOCHRDY	DIORDY

Table 2-4. ISA / Local Bus pin sharing

ISA / IPC	LOCAL BUS
SD[15:0]	PD[15:0]
DREQ_MUX[1:0]	PA[21:20]
SMEMR#	PA[19]
MEMW#	PA[18]
BHE#	PA[17]
AEN	PA[16]
ALE	PA[15]
MEMR#	PA[14]
IOR#	PA[13]
IOW#	PA[12]
REF#	PA[11]
IOCHCK#	PA[10]
GPIOCS#	PA[9]
ZWS#	PA[8]
SA[7:4]	PA[7:4]
TC, DACK_ENC[2:0]	PA[3:0]
SA[3]	PRDY
ISAOE#, SA[2:0]	IOCS#[3:0]
DEV_CLK, RTCAS#	FCS#[1:0]
IOCS16#, MASTER#	PRD#[1:0]
SMEMW#, MCS16#	PWR#[1:0]
ISACLK, ISA_CLK2X	

Figure 2-2. Typical ISA/IDE Demultiplexing



## PIN DESCRIPTION

**Table 2-5. Pinout.**

Pin #	Pin name
AF3	SYSRSTI#
AE4	SYSRSTO#
A3	XTALI
C4	XTALO
G23	HCLK
H24	DEV_CLK
AD11	DCLK
AF15	MCLKI
AB23	MCLKO
AE16	MA[0]
AD15	MA[1]
AF16	MA[2]
AE17	MA[3]
AD16	MA[4]
AF17	MA[5]
AE18	MA[6]
AD17	MA[7]
AF18	MA[8]
AE19	MA[9]
AE20	MA[10]
AC19	BA[0]
AF22	CS#[0]
AD21	CS#[1]
AE24	CS#[2]
AD23	CS#[3]
AF23	RAS#[0]
AD22	RAS#[1]
AE21	CAS#[0]
AC20	CAS#[1]
AF20	DQM#[0]
AD19	DQM#[1]
AF21	DQM#[2]
AD20	DQM#[3]
AE22	DQM#[4]
AE23	DQM#[5]
AF19	DQM#[6]
AD18	DQM#[7]
AC22	MWE#
R1	MD[0]
T2	MD[1]
R3	MD[2]
T1	MD[3]
R4	MD[4]
U2	MD[5]
T3	MD[6]
U1	MD[7]
U4	MD[8]
V2	MD[9]

Pin #	Pin name
U3	MD[10]
V1	MD[11]
W2	MD[12]
V3	MD[13]
Y2	MD[14]
W4	MD[15]
Y1	MD[16]
W3	MD[17]
AA2	MD[18]
Y4	MD[19]
AA1	MD[20]
Y3	MD[21]
AB2	MD[22]
AB1	MD[23]
AA3	MD[24]
AB4	MD[25]
AC1	MD[26]
AB3	MD[27]
AD2	MD[28]
AC3	MD[29]
AD1	MD[30]
AF2	MD[31]
AF24	MD[32]
AE26	MD[33]
AD25	MD[34]
AD26	MD[35]
AC25	MD[36]
AC24	MD[37]
AC26	MD[38]
AB25	MD[39]
AB24	MD[40]
AB26	MD[41]
AA25	MD[42]
Y23	MD[43]
AA24	MD[44]
AA26	MD[45]
Y25	MD[46]
Y26	MD[47]
Y24	MD[48]
W25	MD[49]
V23	MD[50]
W26	MD[51]
W24	MD[52]
V25	MD[53]
V26	MD[54]
U25	MD[55]
V24	MD[56]
U26	MD[57]
U23	MD[58]

Pin #	Pin name
T25	MD[59]
U24	MD[60]
T26	MD[61]
R25	MD[62]
R26	MD[63]
F24	PCI_CLKI
D25	PCI_CLKO
B20	AD[0]
C20	AD[1]
B19	AD[2]
A19	AD[3]
C19	AD[4]
B18	AD[5]
A18	AD[6]
B17	AD[7]
C18	AD[8]
A17	AD[9]
D17	AD[10]
B16	AD[11]
C17	AD[12]
B15	AD[13]
A15	AD[14]
C16	AD[15]
B14	AD[16]
D15	AD[17]
A14	AD[18]
B13	AD[19]
D13	AD[20]
A13	AD[21]
C14	AD[22]
B12	AD[23]
C13	AD[24]
A12	AD[25]
C12	AD[26]
A11	AD[27]
D12	AD[28]
B10	AD[29]
C11	AD[30]
A10	AD[31]
D10	CBE[0]
C10	CBE[1]
A9	CBE[2]
B8	CBE[3]
A8	FRAME#
B7	TRDY#
D8	IRDY#
A7	STOP#
C8	DEVSEL#
B6	PAR

## PIN DESCRIPTION

Pin #	Pin name
D7	SERR#
A6	LOCK#
D20	PCI_REQ#[0]
C21	PCI_REQ#[1]
A21	PCI_REQ#[2]
C22	PCI_GNT#[0]
A22	PCI_GNT#[1]
B21	PCI_GNT#[2]
A5	PCI_INT[0]
C6	PCI_INT[1]
B4	PCI_INT[2]
D5	PCI_INT[3]
F2	LA[17]/DA[0]
G4	LA[18]/DA[1]
F3	LA[19]/DA[2]
F1	LA[20]/PCS1#
G2	LA[21]/PCS3#
G1	LA[22]/SCS1#
H2	LA[23]/SCS3#
J4	SA[0] <sup>2</sup>
H1	SA[1] <sup>2</sup>
H3	SA[2] <sup>2</sup>
J2	SA[3] <sup>2</sup>
J1	SA[4] <sup>2</sup>
K2	SA[5] <sup>2</sup>
J3	SA[6] <sup>2</sup>
K1	SA[7] <sup>2</sup>
K4	SA[8] <sup>2</sup>
L2	SA[9] <sup>2</sup>
K3	SA[10] <sup>2</sup>
L1	SA[11] <sup>2</sup>
M2	SA[12] <sup>2</sup>
M1	SA[13] <sup>2</sup>
L3	SA[14] <sup>2</sup>
N2	SA[15] <sup>2</sup>
M4	SA[16] <sup>2</sup>
M3	SA[17] <sup>2</sup>
P2	SA[18] <sup>2</sup>
P4	SA[19] <sup>2</sup>
K25	SD[0]
L24	SD[1]
K26	SD[2]
K23	SD[3]
J25	SD[4]
K24	SD[5]
J26	SD[6]
H25	SD[7]
H26	SD[8]

Pin #	Pin name
J24	SD[9]
G25	SD[10]
H23	SD[11]
D24	SD[12]
C26	SD[13]
A25	SD[14]
B24	SD[15]
AD4	ISA_CLK
AF4	ISA_CLK2X
C9	OSC14M
P25	ALE
AE8	ZWS#
R23	BHE#
P26	MEMR#
R24	MEMW#
N25	SMEMR#
N23	SMEMW#
N26	IOR#
P24	IOW#
N24	MCS16#
M26	IOCS16#
M25	MASTER#
L25	REF#
M24	AEN
L26	IOCHCK#
T24	IOCHRDY
M23	ISAOE#
A4	RTCAS#
P3	RTCDS#
R2	RTCRW#
P1	RMRTCCS#
AE3	GPIOCS#
E23	IRQ_MUX[0]
D26	IRQ_MUX[1]
E24	IRQ_MUX[2]
C25	IRQ_MUX[3]
A24	DREQ_MUX[0]
B23	DREQ_MUX[1]
C23	DACK_ENC[0]
A23	DACK_ENC[1]
B22	DACK_ENC[2]
D22	TC
N3	KBCS#
B1	PIRQ
C2	SIRQ
C1	PDRQ
D2	SDRQ
D3	PBACK#

Pin #	Pin name
D1	SDACK#
E2	PDIOR#
E4	PDIOW#
E3	SDIOR#
E1	SDIOW#
AF9	RED
AE9	GREEN
AD8	BLUE
AC5	VSYNC
AE5	HSYNC
AC10	VREF_DAC
AE10	RSET
AD7	COMP
AF8	VDD_DAC1
AD9	VDD_DAC2
AC9	VSS_DAC1
AF10	VSS_DAC2
AE15	VCLK
AD5	VIN[0]
AF7	VIN[1]
AF5	VIN[2]
AE6	VIN[3]
AC7	VIN[4]
AD6	VIN[5]
AF6	VIN[6]
AE7	VIN[7]
AD10	RED_TV
AF11	GREEN_TV
AE12	BLUE_TV
AF14	CVBS
AE11	IREF1_TV
AF12	VREF1_TV
AE14	IREF2_TV
AC14	VREF2_TV
AD12	VDDA_TV
AE13	VCS
AC12	ODD_EVEN
AF13	VSSA_TV
C5	SPKRD
B5	SCL
C7	SDA
B3	SCAN_ENABLE
G24	VDD_CPUCLK_PLL
AD13	VDD_DCLK_PLL

## PIN DESCRIPTION

Pin #	Pin name
F25	VDD_DEVCLK_PLL
AC17	VDD_MCLKI_PLL
AC15	VDD_MCLKO_PLL
F26	VDD_HCLK_PLL
A16	VDD5
B11	VDD5
B9	VDD5
D18	VDD5
D6	VDD
D11	VDD
D16	VDD
D21	VDD
F4	VDD
F23	VDD
L4	VDD
L23	VDD
T4	VDD
T23	VDD
AA4	VDD
AA23	VDD
AC6	VDD
AC11	VDD
AC16	VDD
AC21	VDD
E25	VSS_DLL
E26	VSS_DLL
A1:2	VSS
A26	VSS
B2	VSS
B25:26	VSS
C3	VSS
C24	VSS
D4	VSS
D9	VSS
D14	VSS
D19	VSS
D23	VSS
H4	VSS
J23	VSS
L11:16	VSS
M11:16	VSS
N4	VSS
N11:16	VSS
P11:16	VSS
P23	VSS
R11:16	VSS
T11:16	VSS
V4	VSS

Pin #	Pin name
W23	VSS
AC4	VSS
AC8	VSS
AC13	VSS
AC18	VSS
AC23	VSS
AD3	VSS
AD14	VSS
AD24	VSS
AE1:2	VSS
AE25	VSS
AF1	VSS
AF25	VSS
AF26	VSS
A20	<i>Unconnected</i>
C15	<i>Unconnected</i>
G3	<i>Unconnected</i>
G26	<i>Unconnected</i>
N1	<i>Unconnected</i>
W1	<i>Unconnected</i>
AC2	<i>Unconnected</i>

### 3 STRAP OPTIONS

This chapter defines the STPC Consumer-S Strap Options and their location

Memory Data Lines	Refer to	Designation	Location	Actual Settings	Set to '0'	Set to '1'
MD0	-	Reserved	Index 4A, bit 0	-	-	-
MD1	-	Reserved	Index 4A, bit 1	-	-	-
MD2	-	Reserved	Index 4A, bit 2	-	-	-
MD3	-	Reserved	Index 4A, bit 3	-	-	-
MD4	-	Reserved	Index 4A, bit 4	-	-	-
MD5	-	Reserved	Index 4A, bit 5	-	-	-
MD6	-	Reserved	Index 4A, bit 6	-	-	-
MD7	-	Reserved	Index 4A, bit 7	-	-	-
MD8	-	Reserved	Index 4B, bit 0	-	-	-
MD9	-	Reserved	Index 4B, bit 1	-	-	-
MD10	-	Reserved	Index 4B, bit 2	-	-	-
MD11	-	Reserved	Index 4B, bit 3	-	-	-
MD12	-	Reserved	Index 4B, bit 4	-	-	-
MD13	-	Reserved	Index 4B, bit 5	-	-	-
MD14	-	Reserved	Index 4B, bit 6	-	-	-
MD15	-	Reserved	Index 4B, bit 7	-	-	-
MD16	ISA Control	Master#	Index 4C, bit 0	User defined	Test mode	Normal
MD17	PCI Clock	PCI_CLKO Divisor	Index 4C, bit 1	User defined	HCLK / 3	HCLK / 2
MD18	Host Clock	HCLK Pad Direction	Index 4C, bit 2	User defined	External	Internal
MD19	Memory Clock	MCLK Pad Direction	Index 4C, bit 3	User defined	External	Internal
MD20	Dot Clock	DCLK Pad Direction	Index 4C, bit 4	User defined	External	Internal
MD21	-	Reserved	Index 5F, bit 0	Pull up	-	-
MD22	-	Reserved	Index 5F, bit 1	Pull up	-	-
MD23	-	Reserved	Index 5F, bit 2	Pull up	-	-
MD24	HCLK	HCLK PLL Speed	Index 5F, bit 3	User defined	000	25 MHz
MD25			Index 5F, bit 4	User defined	001	33 MHz
MD26			Index 5F, bit 5	User defined	010	100 MHz
					011	50 MHz
					100	60 MHz
					101	66 MHz
					110	75 MHz
					111	90 MHz
MD27	-	Reserved	Hardware	Pull down	-	-
MD28	-	Reserved	Hardware	Pull down	-	-
MD29	-	Reserved	Hardware	Pull down	-	-
MD30	-	Reserved	Hardware	Pull down	-	-
MD31	-	Reserved	Hardware	Pull down	-	-
MD32	-	Reserved	Hardware	Pull down	-	-
MD33	-	Reserved	Hardware	Pull down	-	-
MD34	-	Reserved	Hardware	Pull down	-	-
MD35	-	Reserved	Hardware	Pull down	-	-

Note; Where the indication hardware appears, the strap options are selected directly on the board by jumpers or resistances. Refer to the reference schematics for examples.

## STRAP OPTIONS

Memory Data Lines	Refer to	Designation	Location	Actual Settings	Set to '0'	Set to '1'
MD36	-	Reserved	-	-	-	-
MD37	-	Reserved	-	-	-	-
MD38	-	Reserved	-	-	-	-
MD39	-	Reserved	-	-	-	-
MD40	CPU	CPU Mode	Hardware	User defined	DX1	DX2
MD41	-	Reserved	Hardware	Pull down	-	-
MD42	-	Reserved	Hardware	Pull up	-	-
MD43	-	Reserved	Hardware	Pull down	-	-
MD44	-	Reserved	Hardware	Pull down	-	-
MD45	-	Reserved	Hardware	Pull up	-	-
MD46	-	Reserved	Hardware	Pull down	-	-
MD47	-	Reserved	Hardware	Pull down	-	-
MD48	-	Reserved	Hardware	Pull up	-	-

Note; Where the indication hardware appears, the strap options are selected directly on the board by jumpers or resistances. Refer to the reference schematics for examples.

### 3.1 Power on strap registers description

#### 3.1.1 Strap register 0 Configuration Index 4Ah (Strap0)

*This register is Reserved.*

#### 3.1.2 Strap register 1 Configuration Index 4Bh (Strap1)

*This register is Reserved.*

#### 3.1.3 Strap register 2 Configuration Index 4Ch (Strap2)

Bits 7-5 *Reserved.*

Bit 4 This bit reflects the **value sampled on MD[20] pin** and controls the Dot clock (DCLK) source as follows:

- 0: External. DCLK pin is an input.
- 1: Internal. DCLK pin is an output and is connected to the internal frequency synthesizer output.

Note this bit is writeable as well as readable.

Bit 3 This bit reflects the **value sampled on MD[19] pin** and controls the Memory clock output (MCLKO) source as follows:

- 0: External. MCLKO pin is tristated.

1: Internal. MCLKO pin is an output and is connected to the internal frequency synthesizer output.

Bit 2 This bit reflects the **value sampled on MD[18] pin** and controls the Host/CPU clock source as follows:

0: External. HCLK pin is an input.

1: Internal. HCLK pin is an output and is connected to the internal frequency synthesizer output.

Bit 1 This bit reflects the **value sampled on MD[17] pin** and controls the PCI clock output as follows:

0: PCI clock output = HCLK / 3

1: PCI clock output = HCLK / 2

Bit 0 This bit reflects the **value sampled on MD[16] pin** and controls the configuration of MASTERx and either SD[15:8] (in user mode) or VIN[7:0] for use in test/debug modes.

0: Configured as test bus.

1: Configured as normal IOs.

This register defaults to the values sampled on MD[23] & MD[20:16] pins after reset.



### 3.1.4 HCLK Strap register Configuration Index 5Fh (HCLK\_Strap)

Bits 7-6 *Reserved*.

Bits 5-3 These pins reflect the **value sampled on MD[26:24] pins** respectively and control the Host clock frequency synthesizer as follows:

Bit 5	Bit 4	Bit 3	Description
0	0	0	25 MHz
0	0	1	33 MHz
0	1	0	100 MHz
0	1	1	50 MHz
1	0	0	60 MHz
1	0	1	66 MHz
1	1	0	75 MHz
1	1	1	90 MHz

Bit 2-0 *Reserved*.

This register defaults to the values sampled on above pins after reset.

The recommended value for these three bits is 110.

### 3.1.5 Delay Programming For DLL (DLL\_Prog)

The bits MD[30:27] are used to set the delay of the host clock entering the on chip DLL used to generate PCI\_CLKO that is synchronous with HCLK. Please refer to the STPC Consumer-S Reference Design Schematics for the appropriate value or contact your ST application engineer.

### 3.1.6 HCLKI Programming (HCLK\_Prog)

The HCLKI clock signal (the clock that is used in the ADPC std cell logic) is selected and pro-

grammed through strap values on MD[35:31] & MD[46:45].

MD[46:45] set the source of the HCLKI and the programming value if the PLL option is chosen.

MD[46:45] HCLKI source

MD[46]	MD[45]	HCLKI Source
0	0	HCLKI PLL enabled & HCLKI frequency between 16 & 32 MHz
0	1	HCLKI PLL enabled & HCLKI frequency between 32 & 64 MHz
1	0	HCLKI PLL enabled & HCLKI frequency greater than 64 MHz
1	1	HCLKI PLL disabled; delay chains selected

**CPU to HCLKI skew**, MD[35:31] are used to set the correct skew between the HCLKI and the CPU clock. MD[35] controls whether the CPU clock leads (strap to vss) or lags (strap to vdd) the chipset host clock. MD[34:31] set the value of the skew between these two clocks. Contact your ST applications support for the correct value to strap to these bits. These bits are only enabled when MD[46:45] == 11.

### 3.1.7 486 Clock Programming (486\_Prog)

The bit MD[40] is used to set the clock multiplication factor of the 486 core. With the MD[40] pin pulled low the 486 will run in DX (x1) mode, while with the MD[40] pin pulled high the 486 will run in DX2 (x2) mode. The default value of the resistor on this strap input should be a resistor to gnd (DX mode).

**CPU clock tic**, MD[43:41] are used to set the clock tic input value for the 486 core DLL.

The recommended value for these three bits is 010.

## 4 ELECTRICAL SPECIFICATIONS

### 4.1 Introduction

The electrical specifications in this chapter are valid for the STPC Consumer-S.

### 4.2 Electrical Connections

#### 4.2.1 Power/Ground Connections/Decoupling

Due to the high frequency of operation of the STPC Consumer-S, it is necessary to install and test this device using standard high frequency techniques. The high clock frequencies used in the STPC Consumer-S and its output buffer circuits can cause transient power surges when several output buffers switch output levels simultaneously. These effects can be minimized by filtering the DC power leads with low-inductance decoupling capacitors, using low impedance wiring, and by utilizing all of the VSS and VDD pins.

#### 4.2.2 Unused Input Pins

All inputs not used by the designer and not listed in the table of pin connections in Chapter 3 should be connected either to VDD or to VSS. Connect active-high inputs to VDD through a 20 k $\Omega$  ( $\pm 10\%$ ) pull-down resistor and active-low inputs to VSS and connect active-low inputs to VCC through a

20 k $\Omega$  ( $\pm 10\%$ ) pull-up resistor to prevent spurious operation.

#### 4.2.3 Reserved Designated Pins

Pins designated reserved should be left disconnected. Connecting a reserved pin to a pull-up resistor, pull-down resistor, or an active signal could cause unexpected results and possible circuit malfunctions.

### 4.3 Absolute Maximum Ratings

The following table lists the absolute maximum ratings for the STPC Consumer-S device. Stresses beyond those listed under [Table 4-1](#) limits may cause permanent damage to the device. These are stress ratings only and do not imply that operation under any conditions other than those specified in section "Operating Conditions".

Exposure to conditions beyond [Table 4-1](#) may (1) reduce device reliability and (2) result in premature failure even when there is no immediately apparent sign of failure. Prolonged exposure to conditions at or near the absolute maximum ratings ([Table 4-1](#)) may also result in reduced useful life and reliability.

**Table 4-1. Absolute Maximum Ratings**

Symbol	Parameter	Value	Units
V <sub>DDx</sub>	DC Supply Voltage	-0.3, 4.0	V
V <sub>I</sub> , V <sub>O</sub>	Digital Input and Output Voltage	-0.3, VDD + 0.3	V
T <sub>STG</sub>	Storage Temperature	-40, +150	°C
P <sub>TOT</sub>	Total Power Dissipation (HCLK = 90MHz, MCLK = 75MHz)	4.9 <sup>1</sup>	W
Note 1; See <a href="#">Table 5.2</a> for heat dissipation requirements			

#### 4.4 DC Characteristics

**Table 4-2. DC Characteristics**

Recommended Operating conditions :  $V_{DD} = 3.45V \pm 0.15V$ ,  $T_{case} = 0$  to  $100^{\circ}C$  unless otherwise specified

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$V_{DD}$	Operating Voltage		3.3	3.45	3.6	V
$P_{DD}$	Supply Power	$V_{DD}=3.45V$ , $H_{CLK}=75MHz$ , $MCLK=75MHz$		4.5	4.7	W
		$V_{DD}=3.45V$ , $H_{CLK}=90MHz$ , $MCLK=75MHz$		4.6	4.9	W
$H_{CLK}$	Internal Clock	(Note 1)			75	Mhz
$V_{REF}$	DAC Voltage Reference		1.04	1.12	1.20	V
$V_{OL}$	Output Low Voltage	$I_{Load} = 1.5$ to $8mA$ depending of the pin			0.5	V
$V_{OH}$	Output High Voltage	$I_{Load} = -0.5$ to $-8mA$ depending of the pin	2.4			V
$V_{IL}$	Input Low Voltage	Except XTALI	-0.3		0.8	V
		XTALI	-0.3		0.9	V
$V_{IH}$	Input High Voltage	Except XTALI	2.1		$V_{DD}+0.15$	V
		XTALI	2.35		$V_{DD}+0.15$	V
$I_{LK}$	Input Leakage Current	Input, I/O	-5		5	$\mu A$
$I_{dd}$	Dynamic Current	at RESET, $H_{CLK} = 66MHz$ , $V_{DD} = 3.45V$ , @ Room Temp		1.8		A
$C_{IN}$	Input Capacitance	(Note 2)				pF
$C_{OUT}$	Output Capacitance	(Note 2)				pF
$C_{CLK}$	Clock Capacitance	(Note 2)				pF

**Notes:**

1. MHz ratings refer to CPU clock frequency.
2. Not 100% tested.

#### 4.5 AC Characteristics

Table 4-4 through Table 4-9 list the AC characteristics including output delays, input setup requirements, input hold requirements and output float delays. These measurements are based on the measurement points identified in Figure 4-1. The

rising clock edge reference level  $V_{REF}$ , and other reference levels are shown in Table 4-3 below for the STPC Consumer-S. Input or output signals must cross these levels during testing.

Figure 4-1 shows output delay (A and B) and input setup and hold times (C and D). Input setup and hold times (C and D) are specified minimums, defining the smallest acceptable sampling window a synchronous input signal must be stable for correct operation.

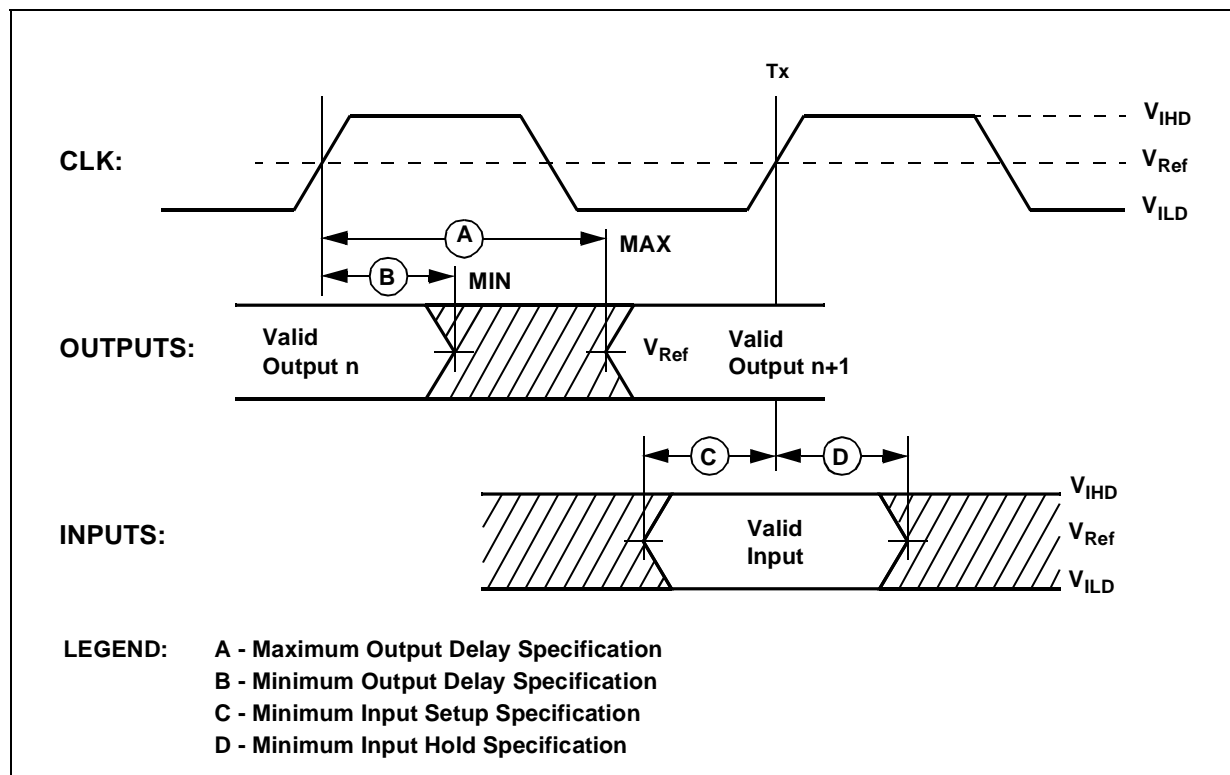
**Table 4-3. Drive Level and Measurement Points for Switching Characteristics**

Symbol	Value	Units
$V_{REF}$	1.5	V
$V_{IHD}$	3.0	V
$V_{ILD}$	0.0	V

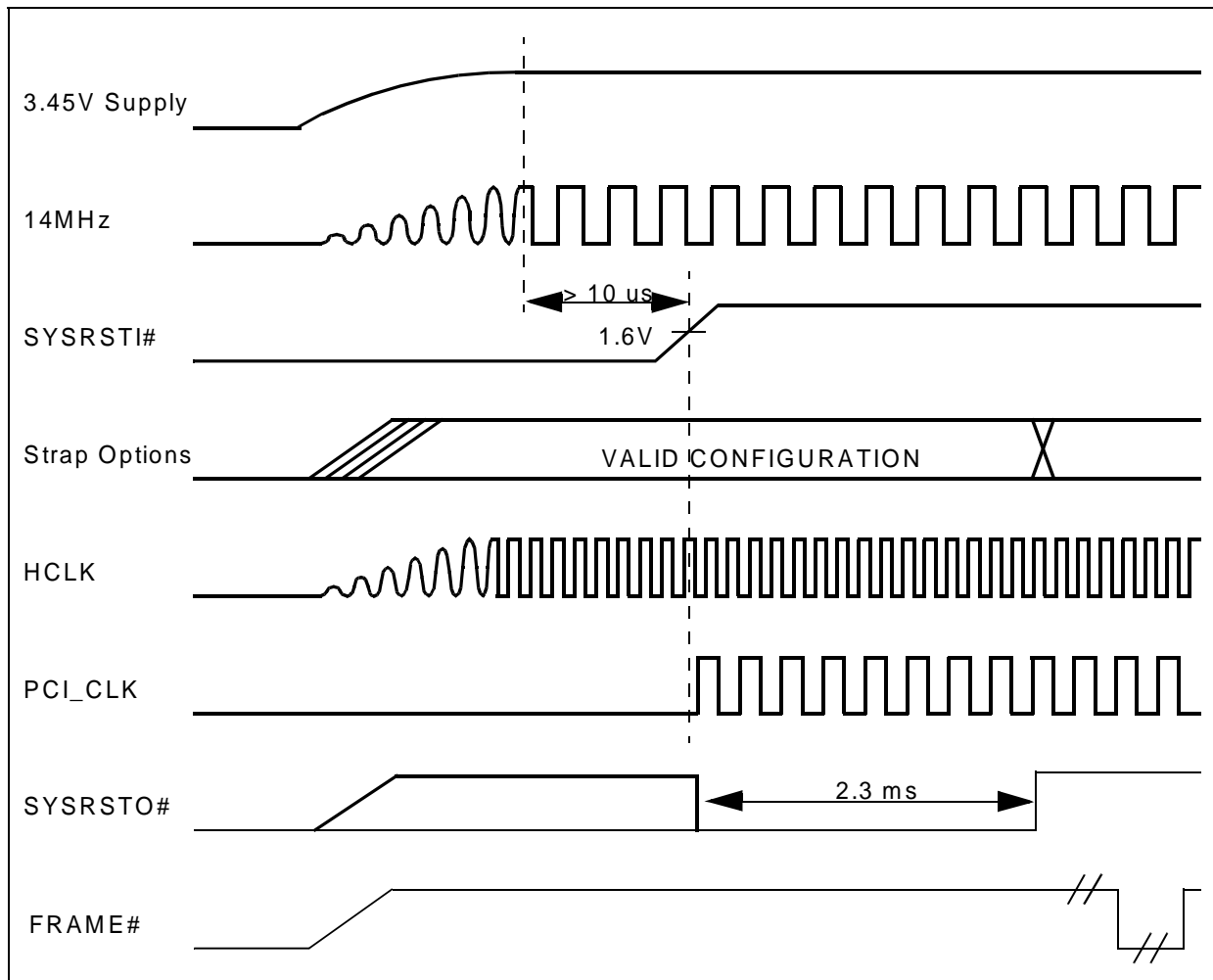
Note: Refer to Figure 4-1.

## ELECTRICAL SPECIFICATIONS

Figure 4-1. Drive Level and Measurement Points for Switching Characteristics



## 4.5.1 POWER ON SEQUENCE



SYSRSTI# has no constraint on its rising time but needs to be set to high at least  $10 \mu s$  after power supply is stable.

Strap Options are continuously sampled during SYSRSTI# low and should be stable. Once SYSRSTI# is high, they MUST NOT CHANGE until SYSRSTO# is high.

## ELECTRICAL SPECIFICATIONS

**Table 4-4. PCI Bus AC Timing**

Name	Parameter	Min	Max	Unit
t1	PCI_CLKI to any output	-	12.8	ns
t2	Setup to PCICKLI	7.0	-	ns
t3	Hold from PCICKLI	1.0	-	ns
t4	PCICKLI to PCI_GNT# output valid	-	12.0	ns
t5	PCI_REQ# setup to PCI_CLKI	12.0	-	ns
T6	PCI_REQ# hold to PCI_CLKI	0.0	-	ns

**Table 4-5. IDE Bus AC Timing**

Name	Parameter	Min	Max	Unit
t20	PCI_CLKI to SA[19:8] Active	-	42	ns
t21	PCI_CLKI to RMRTCCS# Active	-	42	ns
t22	PCI_CLKI to KBCS# Active	-	42	ns
t23	PCI_CLKI to RTCRW# Active	-	42	ns
t24	PCI_CLKI to RTCDS Active	-	42	ns
t25	SA[19:8] Input Setup to SIOR# Rising	-10	10	ns
t26	SA[19:8] Input Hold to SIOR# Rising	-10	10	ns
t27	RMRTCCS# Input Setup to SIOR# Rising	-10	10	ns
t28	RMRTCCS# Input Hold to SIOR# Rising	-10	10	ns
t29	KBCS# Input Setup to SIOR# Rising	-10	10	ns
t30	KBCS# Input Hold to SIOR# Rising	-10	10	ns
t31	RTCRW# Input Setup to SIOR# Rising	-10	10	ns
t32	RTCRW# Input Hold to SIOR# Rising	-10	10	ns
t33	RTCDS Input Setup to SIOR# Rising	-10	10	ns
t34	RTCDS Input Hold to SIOR# Rising	-10	10	ns
t35	PCI_CLKI to LA[23:17] Active	-	28	ns
t36	PCI_CLKI to PDACK# Active	-	32	ns
t37	PCI_CLKI to SDACK Active	-	32	ns
t38	PCI_CLKI to PIOR# Active	-	28	ns
t39	PCI_CLKI to PIOW# Active	-	28	ns
t40	PCI_CLKI to SIOR# Active	-	28	ns
t41	PCI_CLKI to SIOW# Active	-	28	ns

**Table 4-6. SDRAM Bus AC Timing**

Name	Parameter	Min	Max	Unit
t42	MCLKI to RAS#[1:0] Output Valid	-	6.2	ns
t43	MCLKI to CAS#[1:0] Output Valid	-	6.2	ns
t44	MCLKI to CS#[3:0] Output Valid	-	7.6	ns
t45	MCLKI to DQM#[7:0] Output Valid	-	8.1	ns

Note; The figures are extrapolated from silicon characterisation results and design timing analysis

Please refer to STPC Consumer-S Programming Manual for RDCLK settings

**Table 4-6. SDRAM Bus AC Timing**

Name	Parameter	Min	Max	Unit
t46	MCLKI to MA[11:0] Output Valid	-	6.2	ns
t47	MCLKI to MWE# Output Valid	-	6.2	ns
t48	MCLKI to MD[63:0] Output Valid	-	8.2	ns
t49	MD[63:0] setup to MCKLI (no RDCLK)	8.2	-	ns
t50	MD[63:0] setup to MCKLI (RDCLK at min delay)	4.9	-	ns
t51	MD[63:0] setup to MCKLI (RDCLK at mid delay)	4.0	-	ns
t52	MD[63:0] setup to MCKLI (RDCLK at max delay)	3.0	-	ns
t53	MD[63:0] hold from MCKLI (no RDCLK)	3.1	-	ns
t54	MD[63:0] hold from MCKLI (RDCLK at min delay)	6.5	-	ns
t54	MD[63:0] hold from MCKLI (RDCLK at mid delay)	7.1	-	ns
t55	MD[63:0] hold from MCKLI (RDCLK at max delay)	8.5	-	ns
Note; The figures are extrapolated from silicon characterisation results and design timing analysis Please refer to STPC Consumer-S Programming Manual for RDCLK settings				

**Table 4-7. Video Input/TV Output AC Timing**

Name	Parameter	Min	Max	Unit
t56	VIN[7:0] setup to VCLK	5		ns
t57	VIN[7:0] hold from VCLK	4		ns
t58	VCLK to ODD_EVEN valid		15	ns
t59	VCLK to VCS valid		15	ns
t60	ODD_EVEN setup to VCLK	10		ns
t61	ODD_EVEN hold from VCLK	5		ns
t62	VCS setup to VCLK	10		ns
t63	VCS hold from VCLK	5		ns

**Table 4-8. Graphics Adapter (VGA) AC Timing**

Name	Parameter	Min	Max	Unit
t64	DCLK to VSYNC valid		30	ns
t65	DCLK to HSYNC valid		30	ns

## ELECTRICAL SPECIFICATIONS

Figure 4-2 ISA Cycle (ref table Table 4-9)

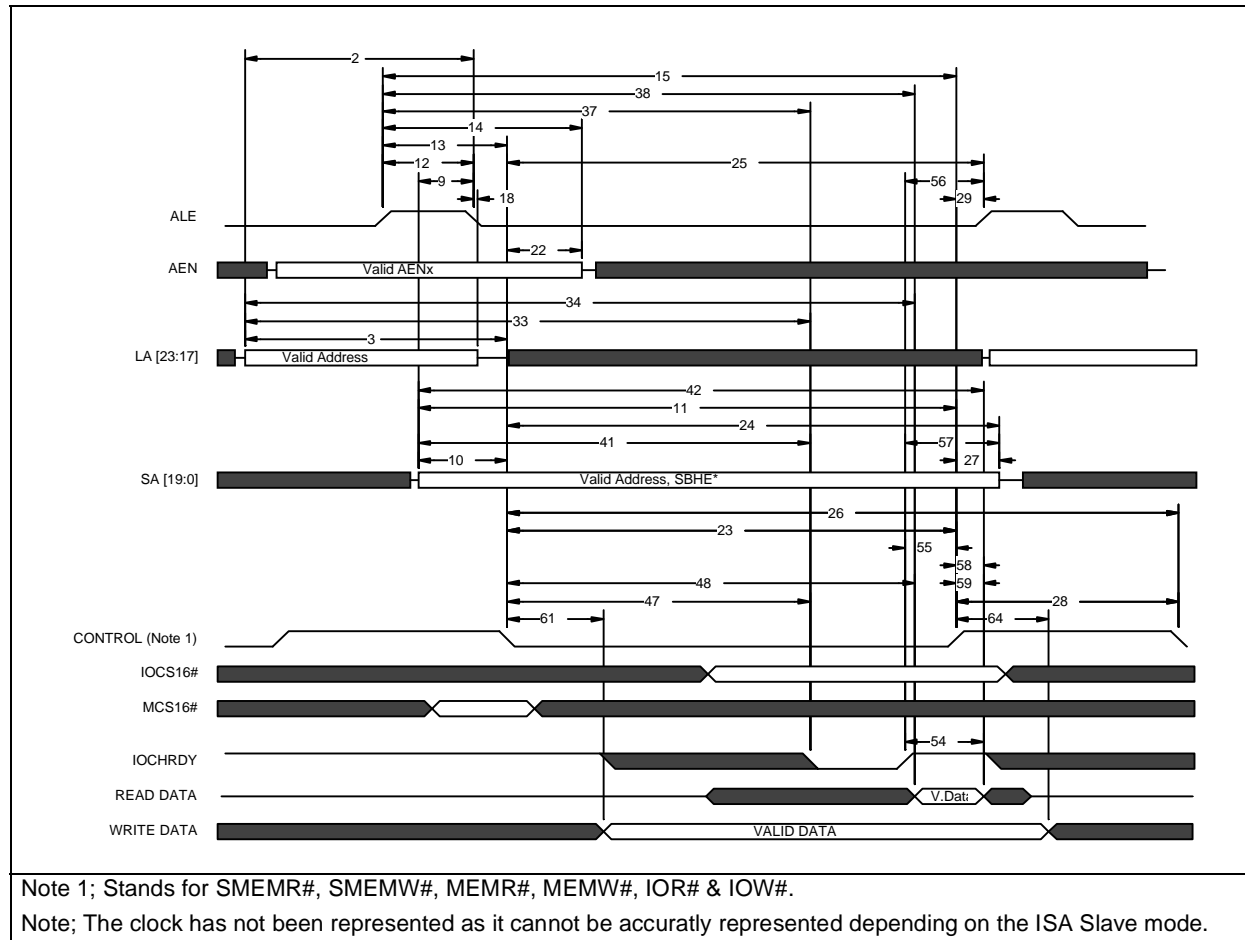


Table 4-9. ISA Bus AC Timing

Name	Parameter	Min	Max	Units
2 <sup>4</sup>	LA[23:17] valid before ALE# negated	5T		Cycles
3 <sup>4</sup>	LA[23:17] valid before MEMR#, MEMW# asserted			
3a <sup>4</sup>	Memory access to 16 bit ISA Slave	5T		Cycles
3b <sup>4</sup>	Memory access to 8 bit ISA Slave	5T		Cycles
9 <sup>4</sup>	SA[19:0] & SBHE valid before ALE# negated	1T		Cycles
10 <sup>4</sup>	SA[19:0] & SBHE valid before MEMR#, MEMW# asserted			
10a <sup>4</sup>	Memory access to 16 bit ISA Slave	2T		Cycles
10b <sup>4</sup>	Memory access to 8 bit ISA Slave	2T		Cycles
10 <sup>4</sup>	SA[19:0] & SBHE valid before SMEMR#, SMEMW# asserted			
10c <sup>4</sup>	Memory access to 16 bit ISA Slave	2T		Cycle
10d <sup>4</sup>	Memory access to 8 bit ISA Slave	2T		Cycle
10e <sup>4</sup>	SA[19:0] & SBHE valid before IOR#, IOW# asserted	2T		Cycles
11 <sup>4</sup>	XTALO to IOW# valid			
11a <sup>4</sup>	Memory access to 16 bit ISA Slave - 2BCLK	2T		Cycles
11b <sup>4</sup>	Memory access to 16 bit ISA Slave - Standard 3BCLK	2T		Cycles

Note; The signal numbering refers to Table 4-2

**Note 4: These timings are extracted from simulations and are not guaranteed by testing**



Table 4-9. ISA Bus AC Timing

Name	Parameter	Min	Max	Units
	11c <sup>4</sup> Memory access to 16 bit ISA Slave - 4BCLK	2T		Cycles
	11d <sup>4</sup> Memory access to 8 bit ISA Slave - 2BCLK	2T		Cycles
11e <sup>4</sup>	Memory access to 8 bit ISA Slave - Standard 3BCLK	2T		Cycles
12 <sup>4</sup>	ALE# asserted before ALE# negated	1T		Cycles
13 <sup>4</sup>	ALE# asserted before MEMR#, MEMW# asserted			
	13a <sup>4</sup> Memory Access to 16 bit ISA Slave	2T		Cycles
	13b <sup>4</sup> Memory Access to 8 bit ISA Slave	2T		Cycles
13 <sup>4</sup>	ALE# asserted before SMEMR#, SMEMW# asserted			
	13c <sup>4</sup> Memory Access to 16 bit ISA Slave	2T		Cycles
	13d <sup>4</sup> Memory Access to 8 bit ISA Slave	2T		Cycles
13e <sup>4</sup>	ALE# asserted before IOR#, IOW# asserted	2T		Cycles
14 <sup>4</sup>	ALE# asserted before AL[23:17]			
	14a <sup>4</sup> Non compressed	15T		Cycles
	14b <sup>4</sup> Compressed	15T		Cycles
15 <sup>4</sup>	ALE# asserted before MEMR#, MEMW#, SMEMR#, SMEMW# negated			
	15a <sup>4</sup> Memory Access to 16 bit ISA Slave- 4 BCLK	11T		Cycles
	15e <sup>4</sup> Memory Access to 8 bit ISA Slave- Standard Cycle	11T		Cycles
18a <sup>4</sup>	ALE# negated before LA[23:17] invalid (non compressed)	14T		Cycles
18a <sup>4</sup>	ALE# negated before LA[23:17] invalid (compressed)	14T		Cycles
22 <sup>4</sup>	MEMR#, MEMW# asserted before LA[23:17]			
	22a <sup>4</sup> Memory access to 16 bit ISA Slave.	13T		Cycles
	22b <sup>4</sup> Memory access to 8 bit ISA Slave.	13T		Cycles
23 <sup>4</sup>	MEMR#, MEMW# asserted before MEMR#, MEMW# negated			
	23b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	9T		Cycles
	23e <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	9T		Cycles
23 <sup>4</sup>	SMEMR#, SMEMW# asserted before SMEMR#, SMEMW# negated			
	23h <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	9T		Cycles
	23i <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	9T		Cycles
23 <sup>4</sup>	IOR#, IOW# asserted before IOR#, IOW# negated			
	23o <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	9T		Cycles
	23r <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	9T		Cycles
24 <sup>4</sup>	MEMR#, MEMW# asserted before SA[19:0]			
	24b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	10T		Cycles
	24d <sup>4</sup> Memory access to 8 bit ISA Slave - 3BCLK	10T		Cycles
	24e <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	10T		Cycles
	24f <sup>4</sup> Memory access to 8 bit ISA Slave - 7BCLK	10T		Cycles
24 <sup>4</sup>	SMEMR#, SMEMW# asserted before SA[19:0]			
	24h Memory access to 16 bit ISA Slave Standard cycle	10T		Cycles
	24i <sup>4</sup> Memory access to 16 bit ISA Slave - 4BCLK	10T		Cycles
	24k <sup>4</sup> Memory access to 8 bit ISA Slave - 3BCLK	10T		Cycles
	24l <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	10T		Cycles
24 <sup>4</sup>	IOR#, IOW# asserted before SA[19:0]			
	24o <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	19T		Cycles
	24r <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	19T		Cycles
25 <sup>4</sup>	MEMR#, MEMW# asserted before next ALE# asserted			

Note; The signal numbering refers to [Table 4-2](#)

Note 4: These timings are extracted from simulations and are not garanteed by testing

## ELECTRICAL SPECIFICATIONS

Table 4-9. ISA Bus AC Timing

Name	Parameter	Min	Max	Units
	25b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	10T		Cycles
	25d <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	10T		Cycles
<b>25<sup>4</sup></b>	<b>SMEMR#, SMEMW# asserted before next ALE# asserted</b>			
	25e <sup>4</sup> Memory access to 16 bit ISA Slave - 2BCLK	10T		Cycles
	25f <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	10T		Cycles
	25h <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	10T		Cycles
<b>25<sup>4</sup></b>	<b>IOR#, IOW# asserted before next ALE# asserted</b>			
	25i <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	10T		Cycles
	25k <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	10T		Cycles
<b>26<sup>4</sup></b>	<b>MEMR#, MEMW# asserted before next MEMR#, MEMW# asserted</b>			
	26b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	12T		Cycles
	26d <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	12T		Cycles
<b>26<sup>4</sup></b>	<b>SMEMR#, SMEMW# asserted before next SMEMR#, SMEMW# asserted</b>			
	26f <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	12T		Cycles
	26h <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	12T		Cycles
<b>26<sup>4</sup></b>	<b>IOR#, IOW# asserted before next IOR#, IOW# asserted</b>			
	26i <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	12T		Cycles
	26k <sup>4</sup> I/O access to 8 bit ISA Slave Standard cycle	12T		Cycles
<b>28<sup>4</sup></b>	<b>Any command negated to MEMR#, SMEMR#, MEMR#, SMEMW# asserted</b>			
	28a <sup>4</sup> Memory access to 16 bit ISA Slave	3T		Cycles
	28b <sup>4</sup> Memory access to 8 bit ISA Slave	3T		Cycles
<b>28<sup>4</sup></b>	<b>Any command negated to IOR#, IOW# asserted</b>			
	28c <sup>4</sup> I/O access to ISA Slave	3T		Cycles
29a <sup>4</sup>	MEMR#, MEMW# negated before next ALE# asserted	1T		Cycles
29b <sup>4</sup>	SMEMR#, SMEMW# negated before next ALE# asserted	1T		Cycles
29c <sup>4</sup>	IOR#, IOW# negated before next ALE# asserted	1T		Cycles
<b>33<sup>4</sup></b>	<b>LA[23:17] valid to IOCHRDY negated</b>			
	33a <sup>4</sup> Memory access to 16 bit ISA Slave - 4 BCLK	8T		Cycles
	33b <sup>4</sup> Memory access to 8 bit ISA Slave - 7 BCLK	14T		Cycles
<b>34<sup>4</sup></b>	<b>LA[23:17] valid to read data valid</b>			
	34b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	8T		Cycles
	34e <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	14T		Cycles
<b>37<sup>4</sup></b>	<b>ALE# asserted to IOCHRDY# negated</b>			
	37a <sup>4</sup> Memory access to 16 bit ISA Slave - 4 BCLK	6T		Cycles
	37b <sup>4</sup> Memory access to 8 bit ISA Slave - 7 BCLK	12T		Cycles
	37c <sup>4</sup> I/O access to 16 bit ISA Slave - 4 BCLK	6T		Cycles
	37d <sup>4</sup> I/O access to 8 bit ISA Slave - 7 BCLK	12T		Cycles
<b>38<sup>4</sup></b>	<b>ALE# asserted to read data valid</b>			
	38b <sup>4</sup> Memory access to 16 bit ISA Slave Standard Cycle	4T		Cycles
	38e <sup>4</sup> Memory access to 8 bit ISA Slave Standard Cycle	10T		Cycles
	38h <sup>4</sup> I/O access to 16 bit ISA Slave Standard Cycle	4T		Cycles
	38i <sup>4</sup> I/O access to 8 bit ISA Slave Standard Cycle	10T		Cycles
<b>41<sup>4</sup></b>	<b>SA[19:0] SBHE valid to IOCHRDY negated</b>			
	41a <sup>4</sup> Memory access to 16 bit ISA Slave	6T		Cycles
	41b <sup>4</sup> Memory access to 8 bit ISA Slave	12T		Cycles

Note; The signal numbering refers to [Table 4-2](#)

**Note 4: These timings are extracted from simulations and are not guaranteed by testing**

## ELECTRICAL SPECIFICATIONS

**Table 4-9. ISA Bus AC Timing**

Name	Parameter	Min	Max	Units
	41c <sup>4</sup> I/O access to 16 bit ISA Slave	6T		Cycles
	41d <sup>4</sup> I/O access to 8 bit ISA Slave	12T		Cycles
<b>42<sup>4</sup></b>	<b>SA[19:0] SBHE valid to read data valid</b>			
	42b <sup>4</sup> Memory access to 16 bit ISA Slave Standard cycle	4T		Cycles
	42e <sup>4</sup> Memory access to 8 bit ISA Slave Standard cycle	10T		Cycles
	42h <sup>4</sup> I/O access to 16 bit ISA Slave Standard cycle	4T		Cycles
	42l <sup>4</sup> I/O access to 8 bit ISA Slave Standard cycle	10T		Cycles
<b>47<sup>4</sup></b>	<b>MEMR#, MEMW#, SMEMR#, SMEMW#, IOR#, IOW# asserted to IOCHRDY negated</b>			
	47a <sup>4</sup> Memory access to 16 bit ISA Slave	2T		Cycles
	47b <sup>4</sup> Memory access to 8 bit ISA Slave	5T		Cycles
	47c <sup>4</sup> I/O access to 16 bit ISA Slave	2T		Cycles
	47d <sup>4</sup> I/O access to 8 bit ISA Slave	5T		Cycles
<b>48<sup>4</sup></b>	<b>MEMR#, SMEMR#, IOR# asserted to read data valid</b>			
	48b <sup>4</sup> Memory access to 16 bit ISA Slave Standard Cycle	2T		Cycles
	48e <sup>4</sup> Memory access to 8 bit ISA Slave Standard Cycle	5T		Cycles
	48h <sup>4</sup> I/O access to 16 bit ISA Slave Standard Cycle	2T		Cycles
	48l <sup>4</sup> I/O access to 8 bit ISA Slave Standard Cycle	5T		Cycles
<b>54<sup>4</sup></b>	<b>IOCHRDY asserted to read data valid</b>			
	54a <sup>4</sup> Memory access to 16 bit ISA Slave	1T(R)/2T(W)		Cycles
	54b <sup>4</sup> Memory access to 8 bit ISA Slave	1T(R)/2T(W)		Cycles
	54c <sup>4</sup> I/O access to 16 bit ISA Slave	1T(R)/2T(W)		Cycles
	54d <sup>4</sup> I/O access to 8 bit ISA Slave	1T(R)/2T(W)		Cycles
55a <sup>4</sup>	IOCHRDY asserted to MEMR#, MEMW#, SMEMR#, SMEMW#, IOR#, IOW# negated	1T		Cycles
55b <sup>4</sup>	IOCHRY asserted to MEMR#, SMEMR# negated (refresh)	1T		Cycles
56 <sup>4</sup>	IOCHRDY asserted to next ALE# asserted	2T		Cycles
57 <sup>4</sup>	IOCHRDY asserted to SA[19:0], SBHE invalid	2T		Cycles
58 <sup>4</sup>	MEMR#, IOR#, SMEMR# negated to read data invalid	0T		Cycles
59 <sup>4</sup>	MEMR#, IOR#, SMEMR# negated to daabus float	0T		Cycles
<b>61<sup>4</sup></b>	<b>Write data before MEMW# asserted</b>			
	61a <sup>4</sup> Memory access to 16 bit ISA Slave	2T		Cycles
	61b <sup>4</sup> Memory access to 8 bit ISA Slave (Byte copy at end of start)	2T		Cycles
<b>61<sup>4</sup></b>	<b>Write data before SMEMW# asserted</b>			
	61c <sup>4</sup> Memory access to 16 bit ISA Slave	2T		Cycles
	61d <sup>4</sup> Memory access to 8 bit ISA Slave	2T		Cycles
<b>61<sup>4</sup></b>	<b>Write Data valid before IOW# asserted</b>			
	61e <sup>4</sup> I/O access to 16 bit ISA Slave	2T		Cycles
	61f <sup>4</sup> I/O access to 8 bit ISA Slave	2T		Cycles
64a <sup>4</sup>	MEMW# negated to write data invalid - 16 bit	1T		Cycles
64b <sup>4</sup>	MEMW# negated to write data invalid - 8 bit	1T		Cycles
64c <sup>4</sup>	SMEMW# negated to write data invalid - 16 bit	1T		Cycles
64d <sup>4</sup>	SMEMW# negated to write data invalid - 8 bit	1T		Cycles
64e <sup>4</sup>	IOW# negated to write data invalid	1T		Cycles
Note; The signal numbering refers to <a href="#">Table 4-2</a>				
<b>Note 4: These timings are extracted from simulations and are not guaranteed by testing</b>				

## ELECTRICAL SPECIFICATIONS

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**Table 4-9. ISA Bus AC Timing**

Name	Parameter	Min	Max	Units
64f <sup>4</sup>	MEMW# negated to copy data float, 8 bit ISA Slave, odd Byte by ISA Master	1T		Cycles
64g <sup>4</sup>	IOW# negated to copy data float, 8 bit ISA Slave, odd Byte by ISA Master	1T		Cycles
Note; The signal numbering refers to <a href="#">Table 4-2</a>				
<b>Note 4: These timings are extracted from simulations and are not guaranteed by testing</b>				

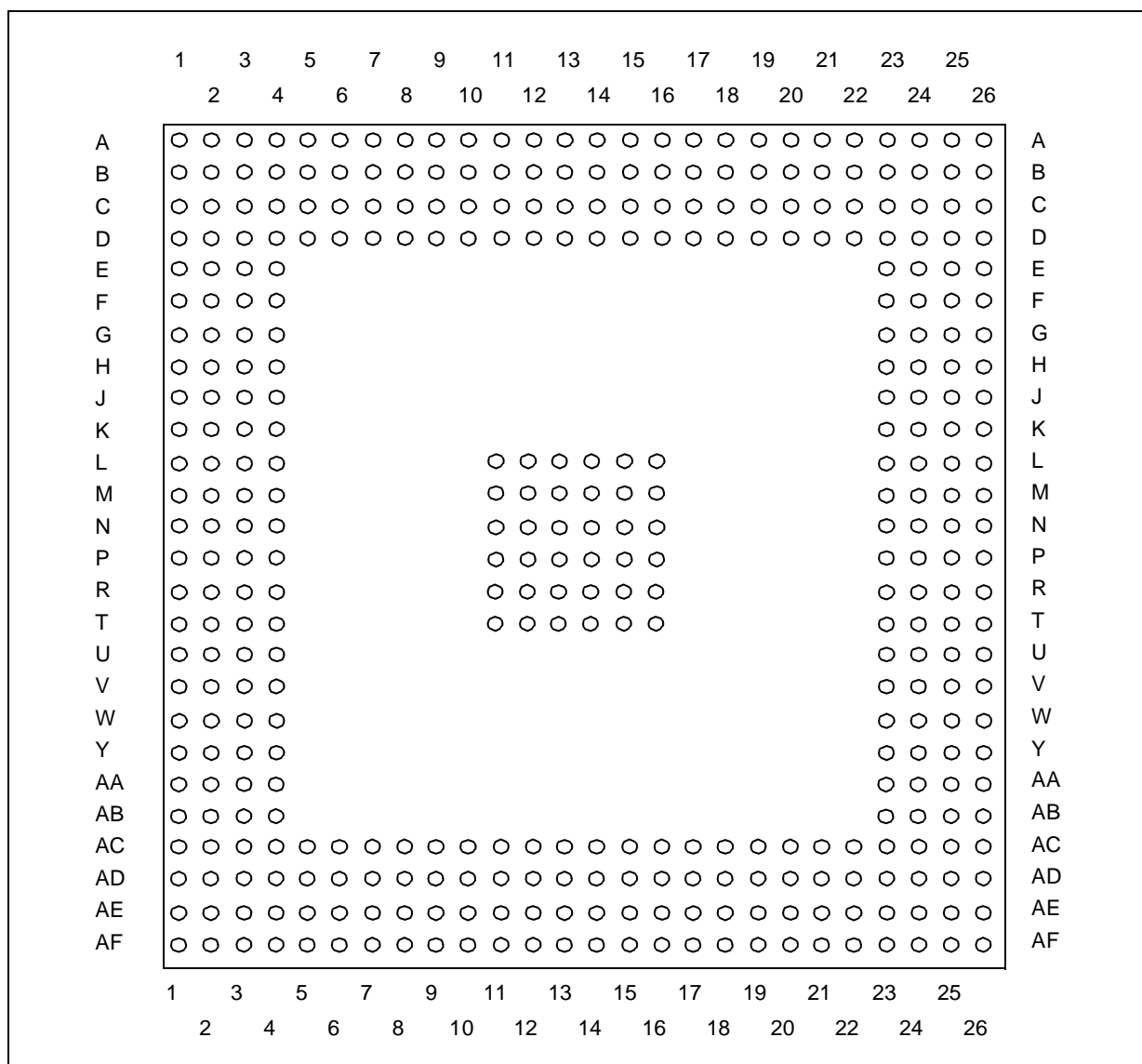
## 5. MECHANICAL DATA

### 5.1 388-Pin Package Dimension

Dimensions are shown in [Figure 5-2](#), [Table 5-1](#) and [Figure 5-3](#), [Table 5-2](#).

The pin numbering for the STPC 388-pin Plastic BGA package is shown in [Figure 5-1](#).

**Figure 5-1. 388-Pin PBGA Package - Top View**



MECHANICAL DATA

Figure 5-2. 388-pin PBGA Package - PCB Dimensions

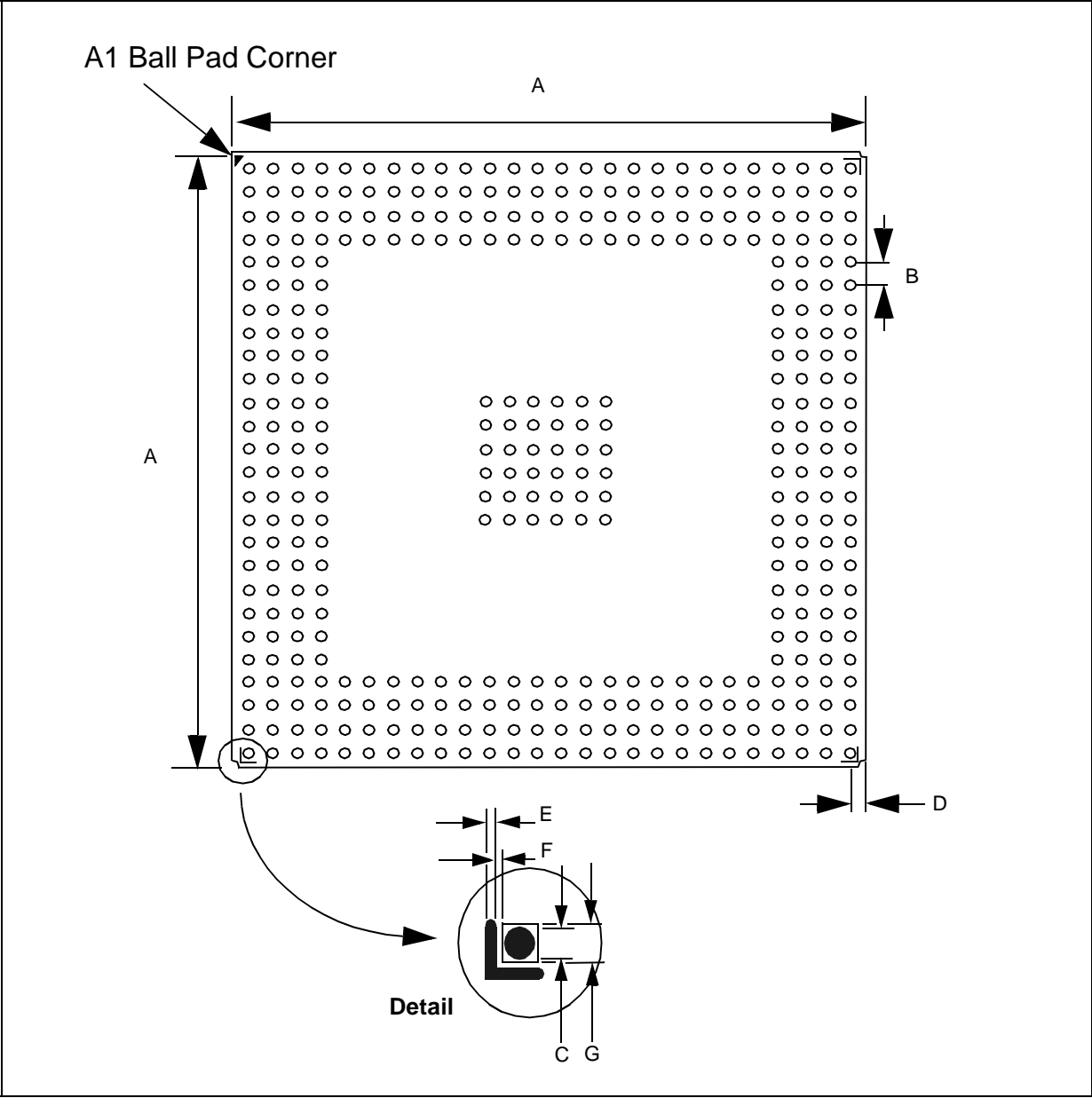


Table 5-1. 388-pin PBGA Package - PCB Dimensions

Symbols	mm			inches		
	Min	Typ	Max	Min	Typ	Max
A	34.95	35.00	35.05	1.375	1.378	1.380
B	1.22	1.27	1.32	0.048	0.050	0.052
C	0.58	0.63	0.68	0.023	0.025	0.027
D	1.57	1.62	1.67	0.062	0.064	0.066
E	0.15	0.20	0.25	0.006	0.008	0.001
F	0.05	0.10	0.15	0.002	0.004	0.006
G	0.75	0.80	0.85	0.030	0.032	0.034

Figure 5-3. 388-pin PBGA Package - Dimensions

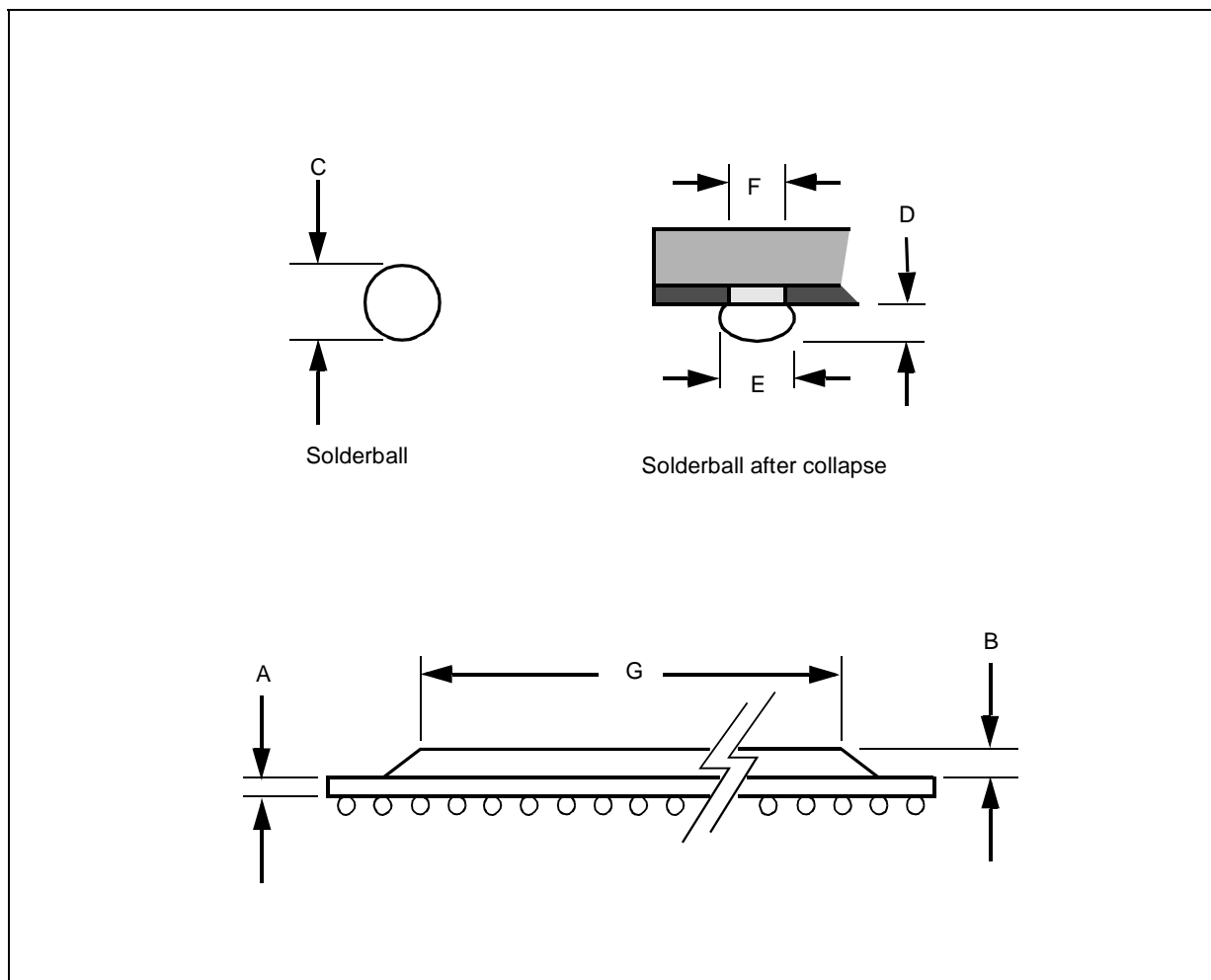


Table 5-2. 388-pin PBGA Package - Dimensions

Symbols	mm			inches		
	Min	Typ	Max	Min	Typ	Max
A	0.50	0.56	0.62	0.020	0.022	0.024
B	1.12	1.17	1.22	0.044	0.046	0.048
C	0.60	0.76	0.92	0.024	0.030	0.036
D	0.52	0.53	0.54	0.020	0.021	0.022
E	0.63	0.78	0.93	0.025	0.031	0.037
F	0.60	0.63	0.66	0.024	0.025	0.026
G		30.0			11.8	

## MECHANICAL DATA

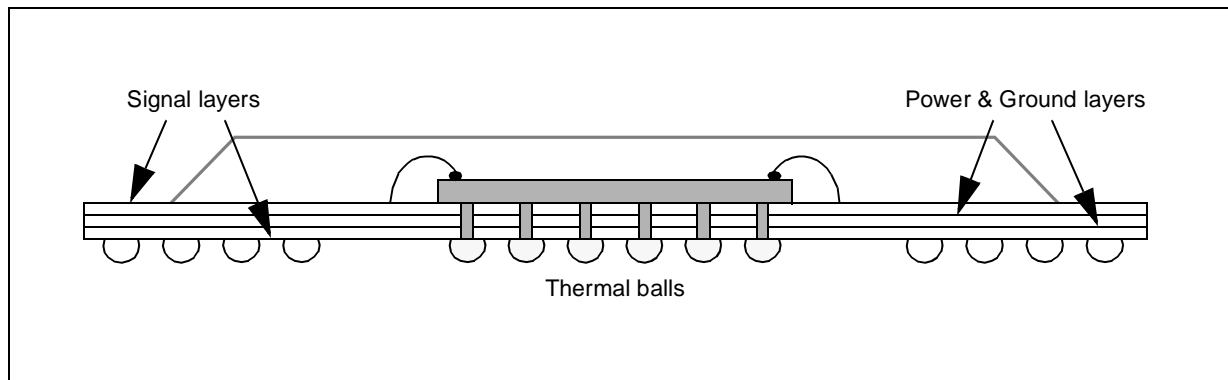
### 5.2 388-Pin Package thermal data

388-pin PBGA package has a Power Dissipation Capability of 4.5W which increases to 6W when used with a Heatsink.

Structure is shown in [Figure 5-4](#).

Thermal dissipation options are illustrated in [Figure 5-5](#) and [Figure 5-6](#).

**Figure 5-4. 388-Pin PBGA structure**



**Figure 5-5. Thermal dissipation without heatsink**

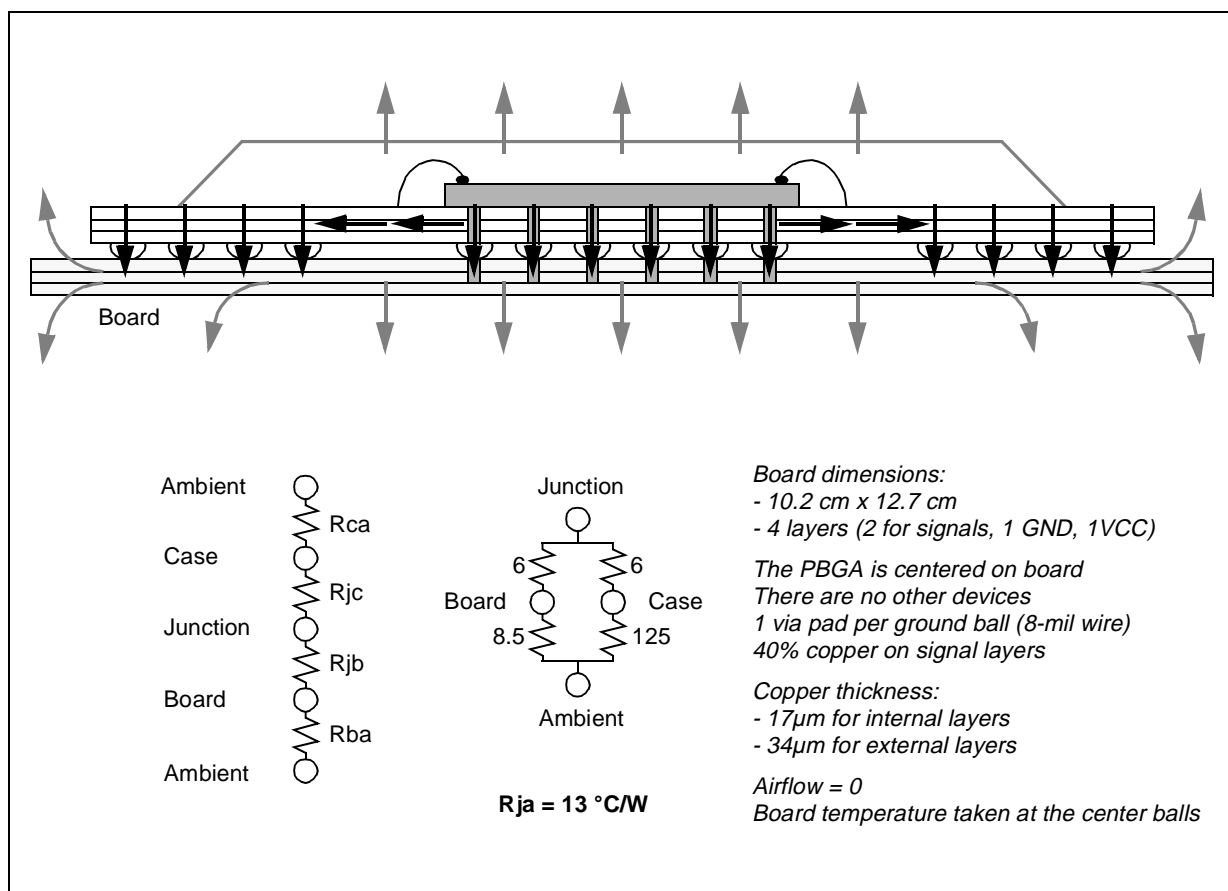
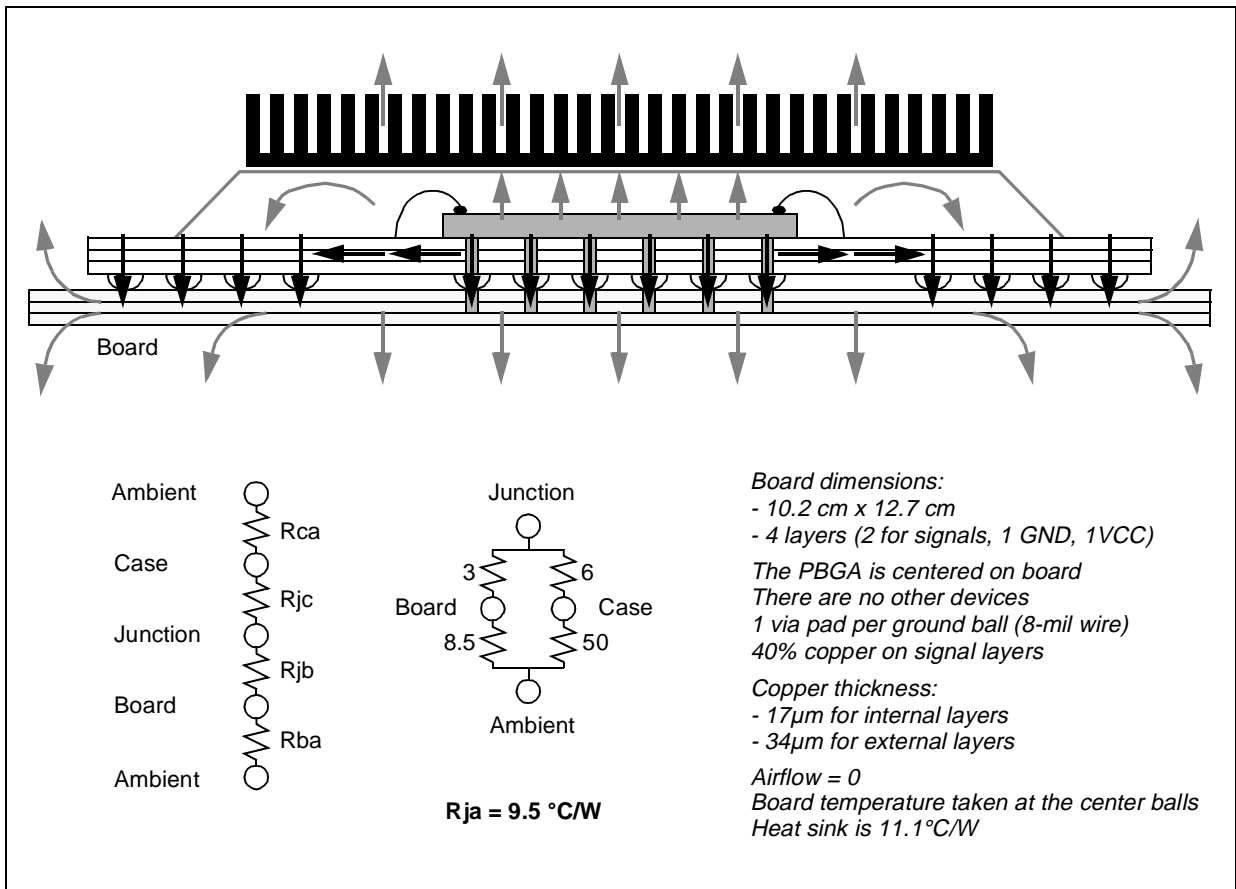




Figure 5-6. Thermal dissipation with heatsink



### 6. BOARD LAYOUT

#### 6.1 Thermal dissipation

Thermal dissipation of the STPC depends mainly on supply voltage. As a result, when the system does not need to work at 3.45V, it is interesting to reduce the voltage to 3.15V, for example, if it is possible. This may save few 100's of mW.

The second area to look at is unused interfaces and functions. Depending on the application, some input signals can be grounded, and some blocks not powered or shutdown. Clock speed dynamic adjustment is also a solution that can be used along with the integrated power management unit.

The standard way to route thermal balls to internal ground layer implements only one via pad for each ball pad, connected using a 8-mil wire.

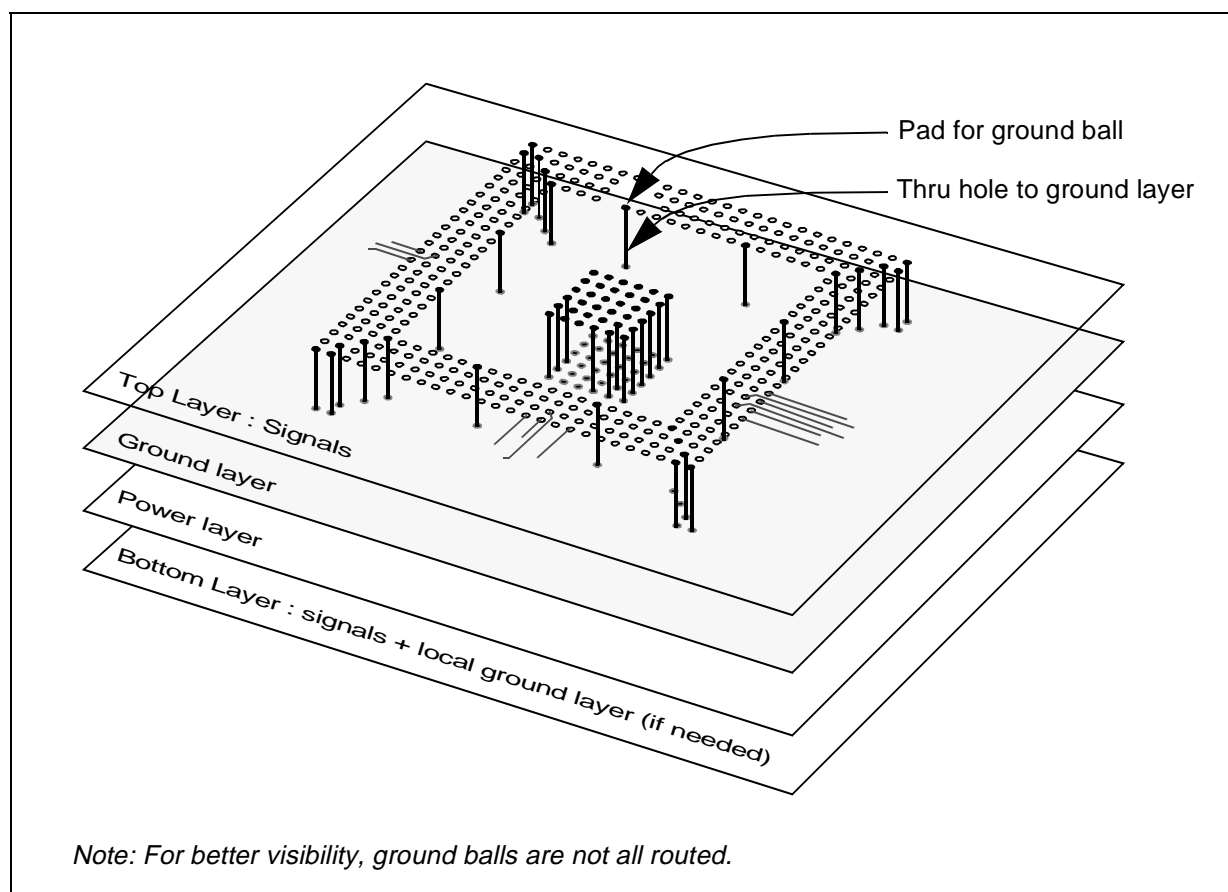
With such configuration the Plastic BGA 388 package does 90% of the thermal dissipation through the ground balls, and especially the central thermal balls which are directly connected to the die, the remaining 10% is dissipated through the case. Adding a heat sink reduces this value to 85%.

As a result, some basic rules has to be applied when routing the STPC in order to avoid thermal problems.

First of all, the whole ground layer acts as a heat sink and ground balls must be directly connected to it as illustrated in [Figure 6-1](#).

If one ground layer is not enough, a second ground plane may be added on solder side.

**Figure 6-1. Ground routing**



When considering thermal dissipation, the most important - and not the more obvious - part of the layout is the connection between the ground balls and the ground layer.

A 1-wire connection is shown in [Figure 6-2](#). The use of a 8-mil wire results in a thermal resistance of  $105^{\circ}\text{C}/\text{W}$  assuming copper is used ( $418 \text{ W}/\text{m}\cdot^{\circ}\text{K}$ ). This high value is due to the thickness ( $34 \mu\text{m}$ ) of the copper on the external side of the PCB.

Considering only the central matrix of 36 thermal balls and one via for each ball, the global thermal resistance is  $2.9^{\circ}\text{C}/\text{W}$ . This can be easily improved using four 10 mil wires to connect to the four vias around the ground pad link as in [Figure 6-3](#). This gives a total of 49 vias and a global resistance for the 36 thermal balls of  $0.6^{\circ}\text{C}/\text{W}$ .

The use of a ground plane like in [Figure 6-4](#) is even better.

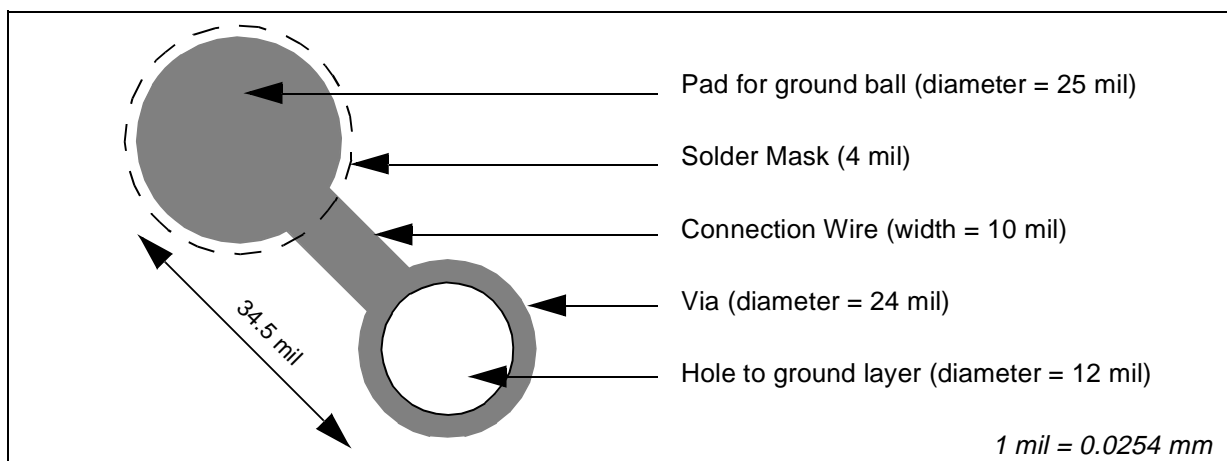
To avoid solder wicking over to the via pads during soldering, it is important to have a solder mask of 4 mil around the pad (NSMD pad), this gives a diameter of 33 mil for a 25 mil ground pad.

To obtain the optimum ground layout, place the vias directly under the ball pads. In this case no local board distortion is tolerated.

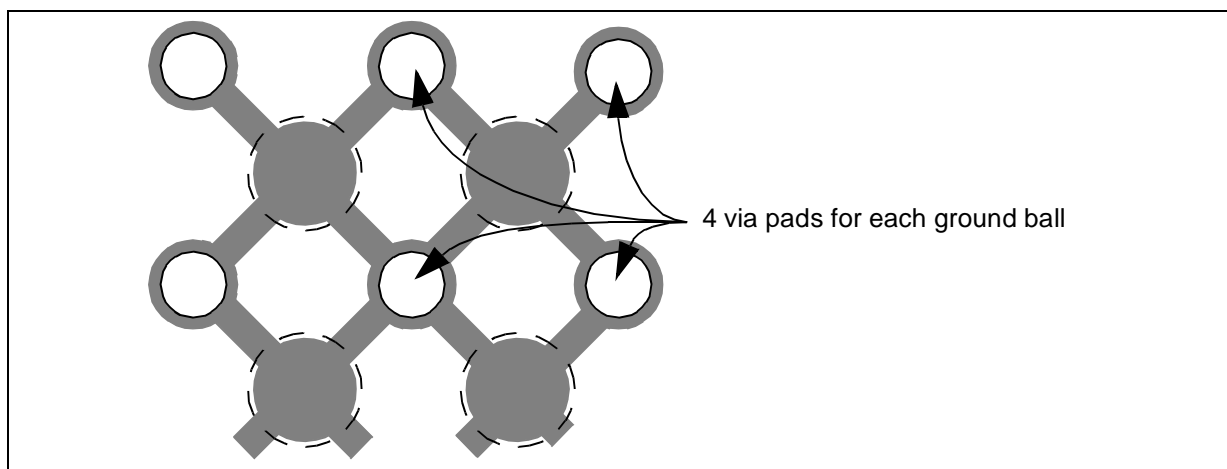
The thickness of the copper on PCB layers is typically  $34 \mu\text{m}$  for external layers and  $17 \mu\text{m}$  for internal layers. That means thermal dissipation is not good and temperature of the board is concentrated around the devices and falls quickly with increased distance.

When it is possible to place a metal layer inside the PCB, this improves dramatically the heat spreading and hence thermal dissipation of the board.

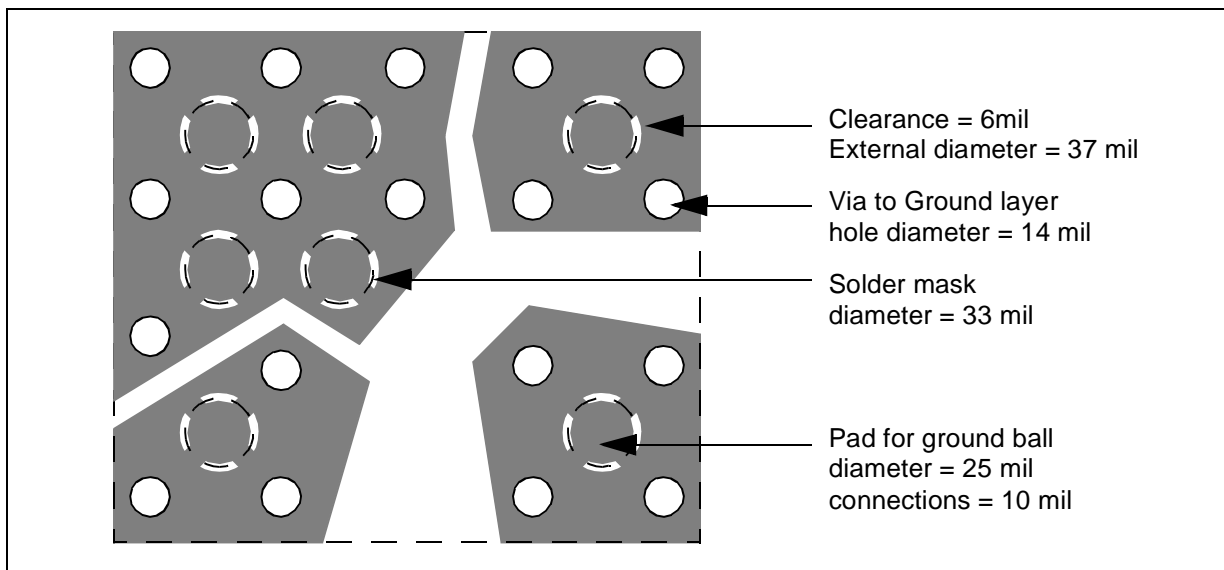
**Figure 6-2. Recommended 1-wire ground pad layout**



**Figure 6-3. Recommended 4-wire ground pad layout**



**Figure 6-4. Optimum layout for central ground ball**



The PBGA Package dissipates also through peripheral ground balls. When a heat sink is placed on the device, heat is more uniformly spread throughout the moulding increasing heat dissipation through the peripheral ground balls.

The more via pads are connected to each ground ball, the more heat is dissipated. The only limitation is the risk of losing routing channels.

Figure 6-5 shows a routing with a good trade off between thermal dissipation and number of routing channels.

A local ground plane on opposite side of the board as shown in Figure 6-6 improves thermal dissipation. It is used to connect decoupling capacitances but can also be used for connection to a heat sink or to the system's metal box for better dissipation.

This possibility of using the whole system's box for thermal dissipation is very useful in case of high temperature inside the system and low temperature outside. In that case, both sides of the PBGA should be thermally connected to the metal chassis in order to propagate the heat flow through the metal. Figure 6-7 illustrates such implementation.

### 6.2 High speed signals

Some Interfaces of the STPC run at high speed and have to be carefully routed or even shielded.

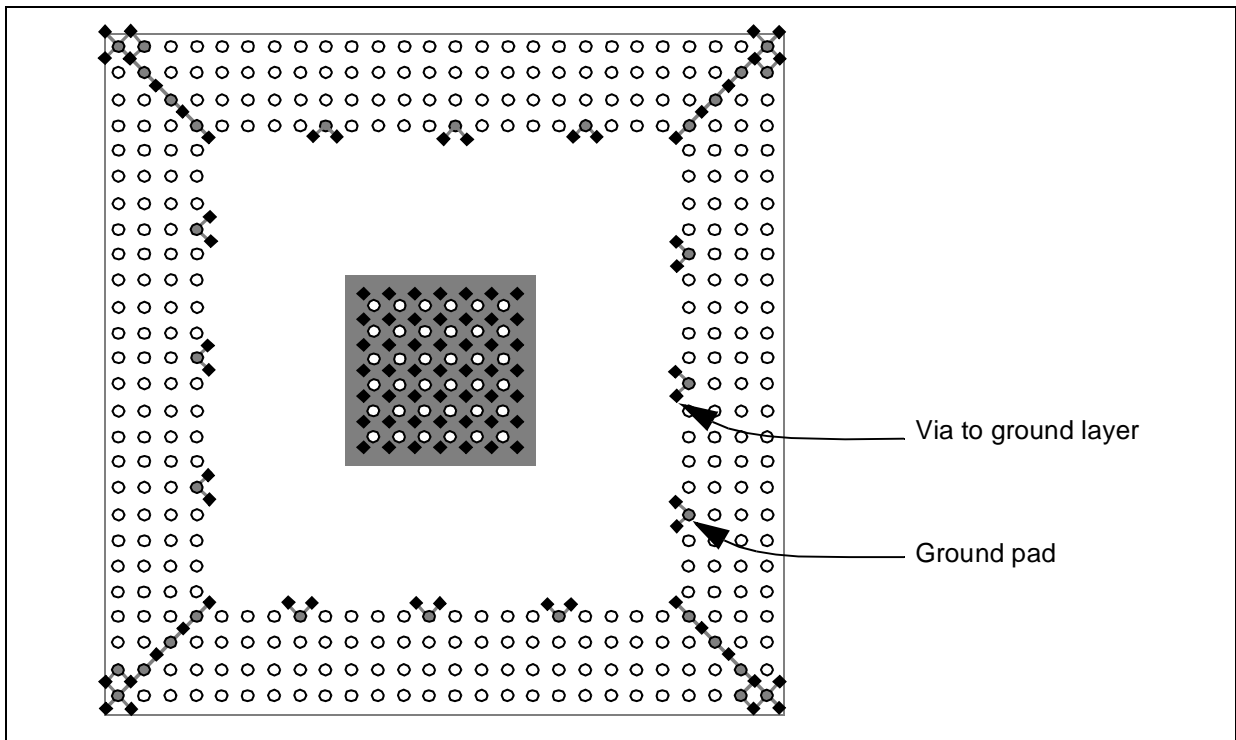
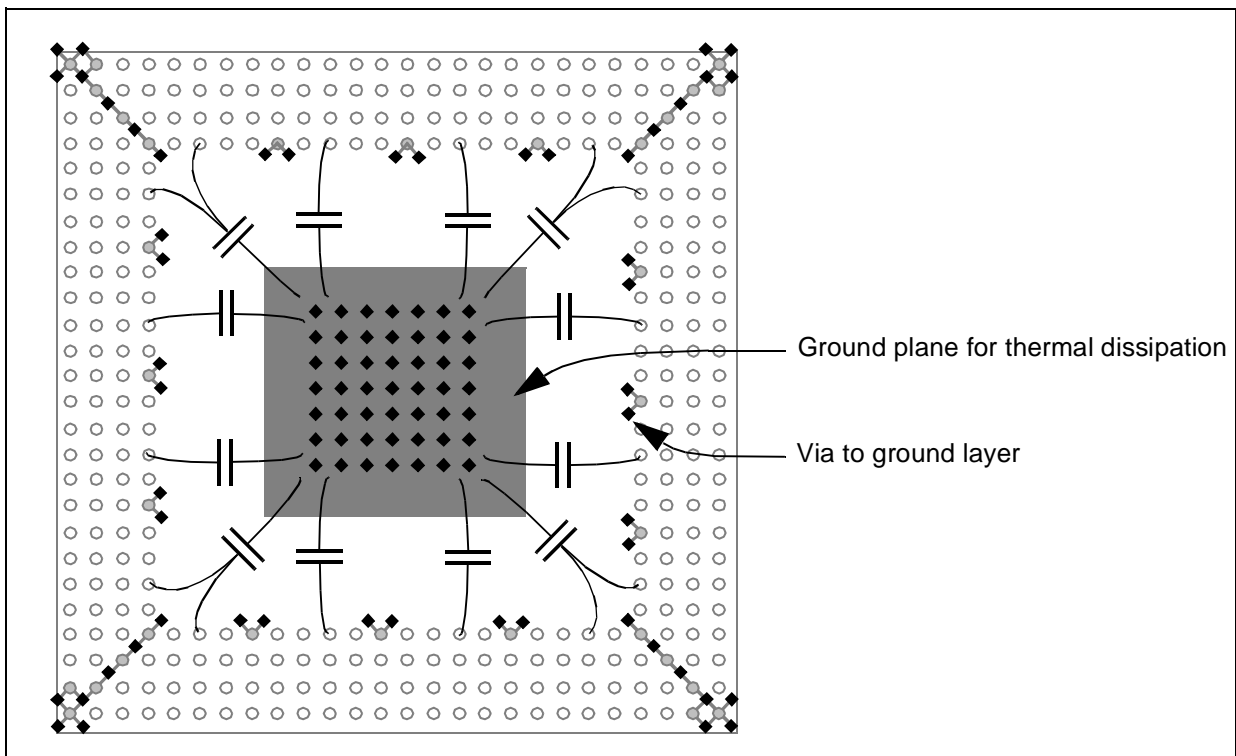
Here is the list of these interfaces, in decreasing speed order:

- 1) Memory Interface.
- 2) Graphics and video interfaces
- 3) PCI bus
- 4) 14MHz oscillator stage

All the clocks have to be routed first and shielded for speeds of 27MHz or more. The high speed signals follow the same constraints, like the memory control signals and the PCI control signals.

The next interfaces to be routed are Memory, Video/graphics, and PCI.

All the analog noise sensitive signals have to be routed in a separate area and hence can be routed independently.

**Figure 6-5. Global ground layout for good thermal dissipation****Figure 6-6. Bottom side layout and decoupling**

## BOARD LAYOUT

Figure 6-7. Use of metal plate for thermal dissipation

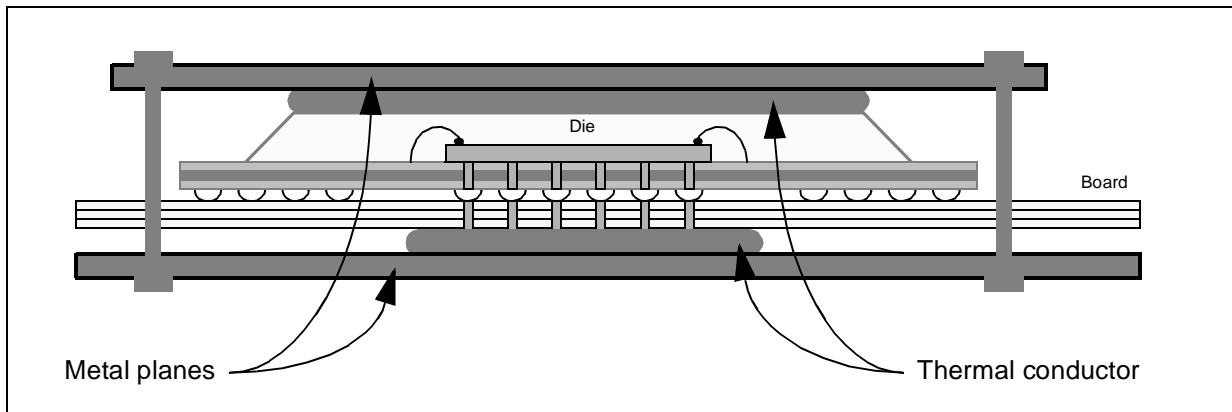
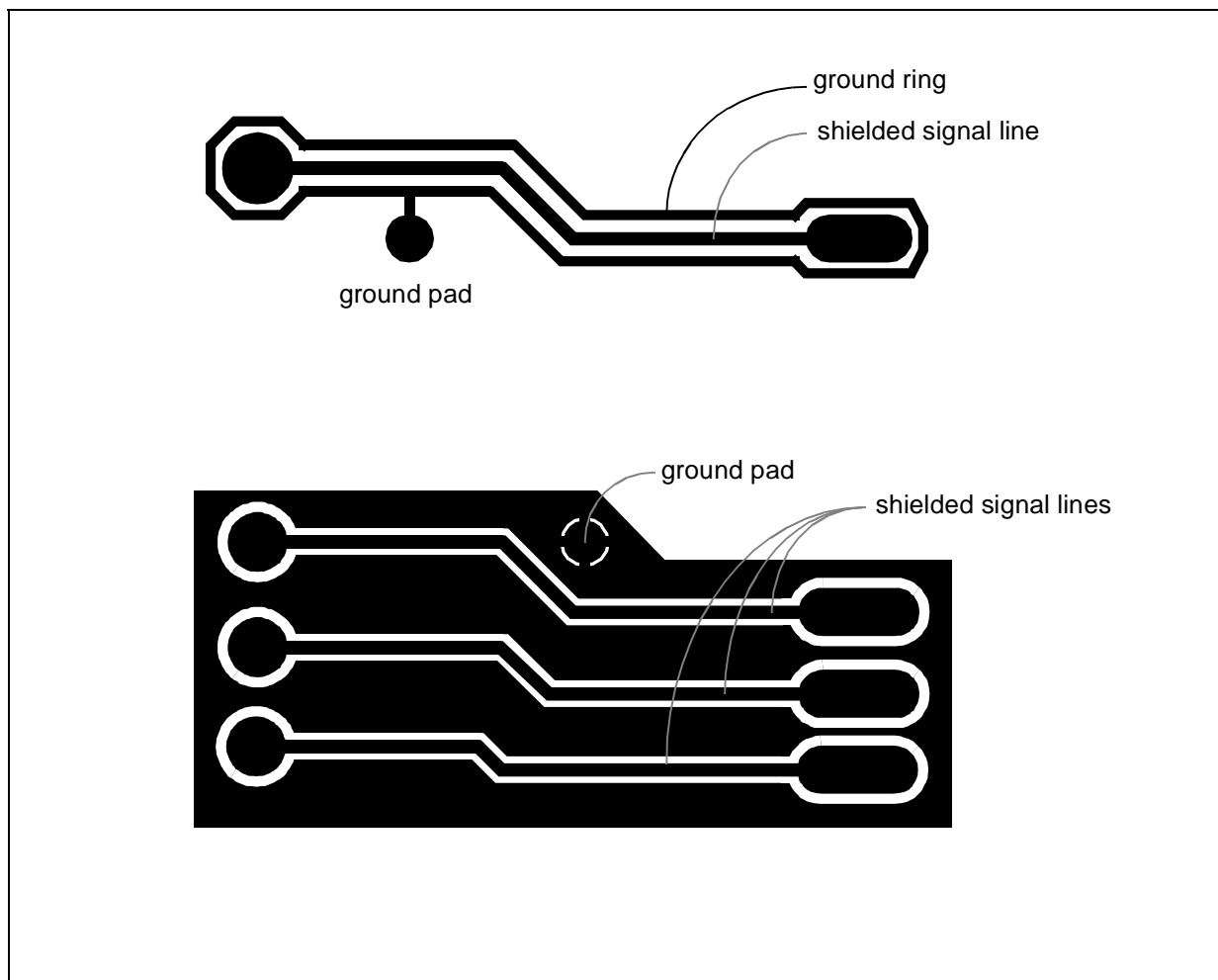


Figure 6-8. Shielding signals



## 6.3 Memory interface

### 6.3.1 Introduction

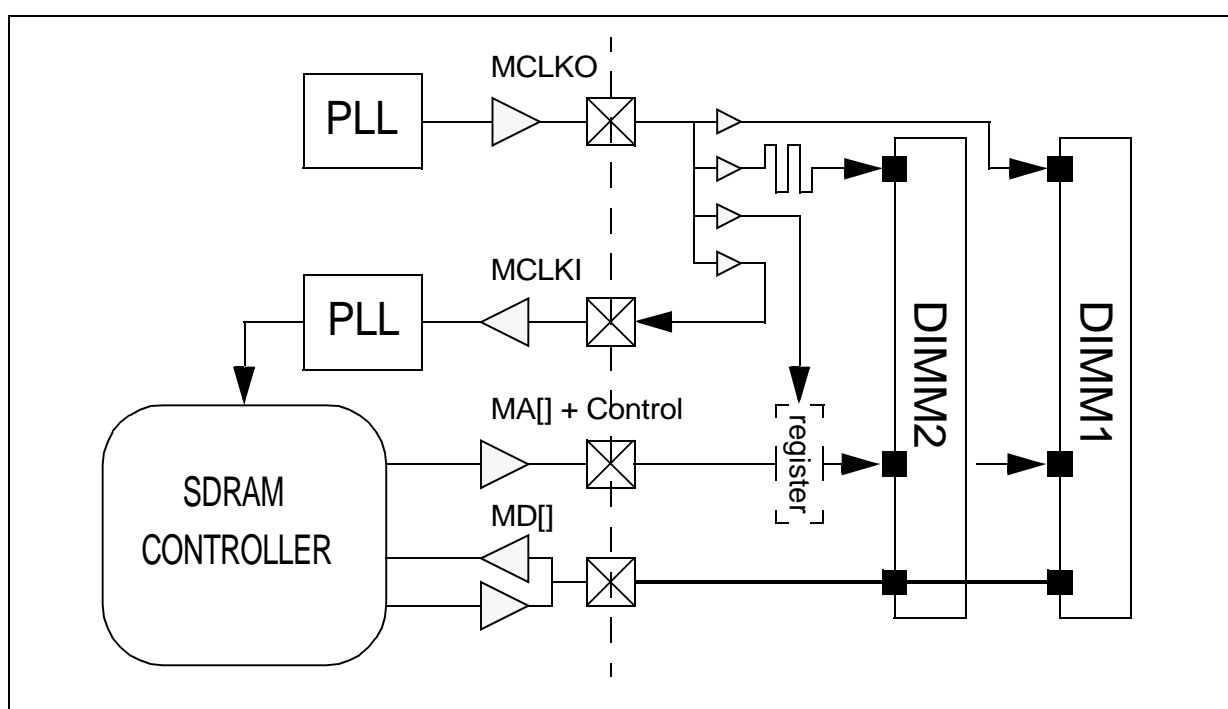
In order to achieve SDRAM memory interfaces which work at clock frequencies of 100MHz and above, careful consideration has to be given to the timing of the interface with all the various electrical and physical constraints taken into consideration. The guidelines described below are related to SDRAM components on DIMM modules. For applications where the memories are directly soldered to the motherboard, the PCB should be laid out such that the trace lengths fit within the constraints shown here. The traces could be slightly longer since the extra routing on the DIMM PCB is

no longer present but it is then up to the user to verify the timings.

### 6.3.2 SDRAM Clocking Scheme

The SDRAM Clocking Scheme deserves a special mention here. Basically the memory clock is generated on-chip through a PLL and goes directly to the MCLKO output pin of the STPC. The nominal frequency is 100MHz. Because of the high load presented to the MCLK on the board by the DIMMs it is recommended to rebuffer the MCLKO signal on the board and balance the skew to the clock ports of the different DIMMs and the MCLKI input pin of STPC.

**Figure 6-9. Clock scheme**



### 6.3.3 Board Layout Issues

The physical layout of the motherboard PCB assumed in this presentation is as shown in [Figure 6-10](#). Because all the memory interface signal balls are located in the same region of the STPC device it is possible to orientate the device to reduce the trace lengths. The worst case routing length to the DIMM1 is estimated to be 100mm.

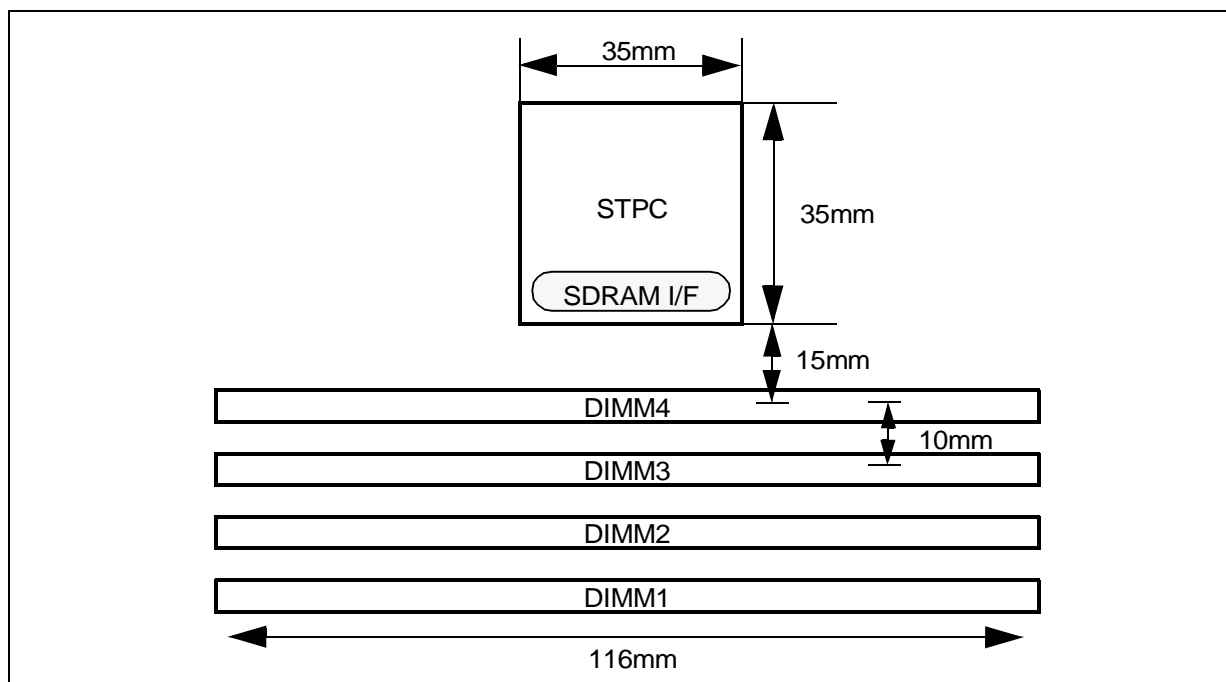
Solid power and ground planes are a must in order to provide good return paths for the signals and to reduce EMI and noise. Also there should be ample high frequency decoupling between the power

and ground planes to provide a low impedance path between the planes for the return paths for signal routings which change layers. If possible the traces should be routed adjacent to the same power or ground plane for the length of the trace.

For the SDRAM interface the most critical signal is the clock. Any skew between the clocks at the SDRAM components and the memory controller will impact the timing budget. In order to get well matched clocks at all the components it is recommended that all the DIMM clock pins, STPC memory clock input (MCLKI) and any other component using the memory clock are individually driven

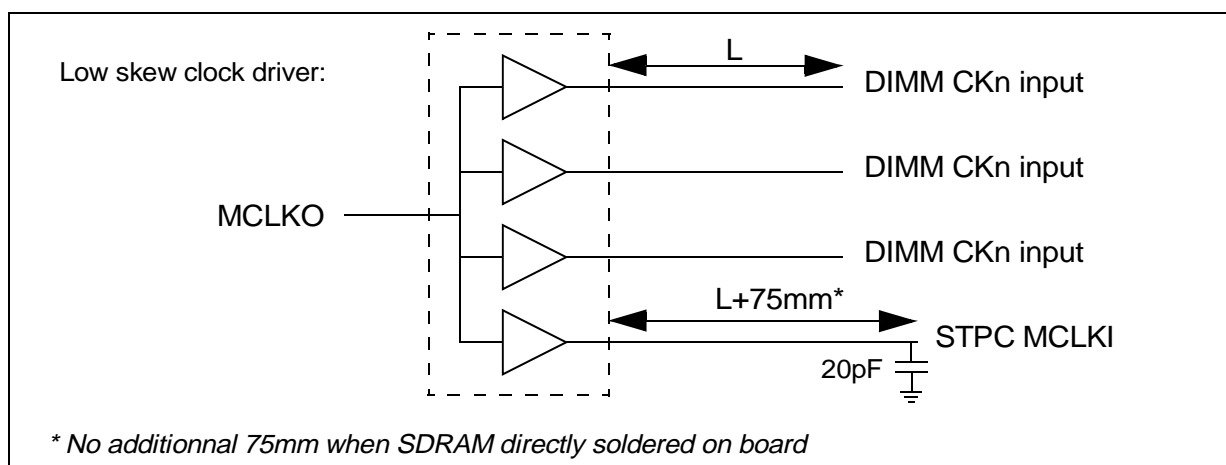
## BOARD LAYOUT

Figure 6-10. DIMM placement



from a low skew clock driver with matched routing lengths. This is shown in Figure 6-11.

Figure 6-11. Clock routing



The maximum skew between pins for this part is 250ps. The important factors for the clock buffer are a consistent drive strength and low skew between the outputs. The delay through the buffer is not important so it does not have to be a zero delay PLL type buffer. The trace lengths from the clock driver to the DIMM CKn pins should be matched exactly. Since the propagation speed can vary between PCB layers the clocks should be routed in a consistent way. The routing to the

STPC memory input should be longer by 75mm to compensate for the extra clock routing on the DIMM. Also a 20pF capacitor should be placed as near as possible to the clock input of the STPC to compensate for the DIMM's higher clock load. The impedance of the trace used for the clock routing should be matched to the DIMM clock trace impedance (60-75 ohms). To minimise crosstalk the clocks should be routed with spacing to adjacent tracks of at least twice the clock trace width.



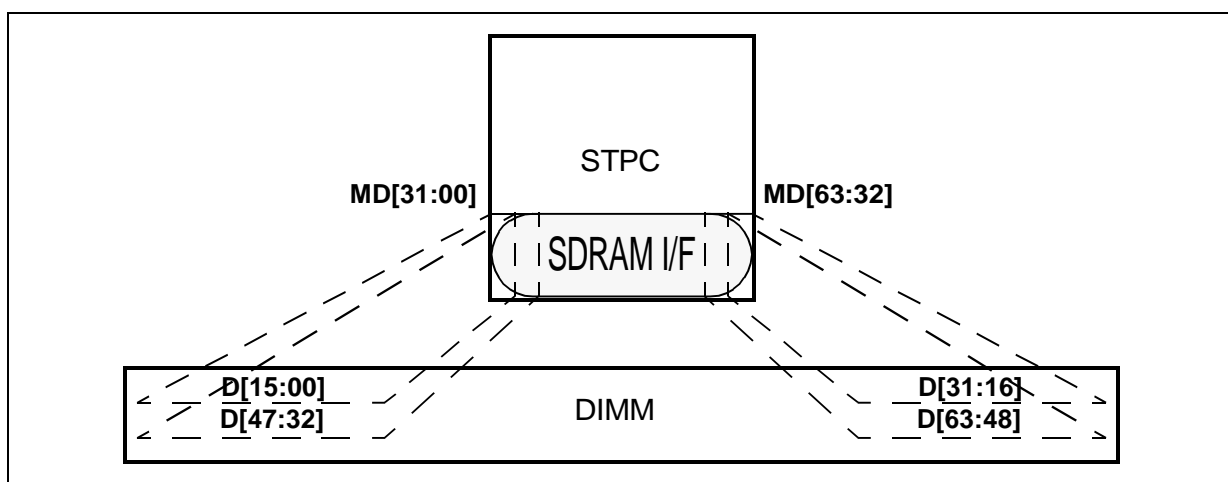
For designs which use SDRAMs directly mounted on the motherboard PCB all the clock trace lengths should be matched exactly.

The DIMM sockets should be populated starting with the furthest DIMM from the STPC device first (DIMM1). There are 2 types of DIMM devices; single row and dual row. The dual row devices require 2 chip select signals to select between the two rows. A STPC device with 4 chip select control

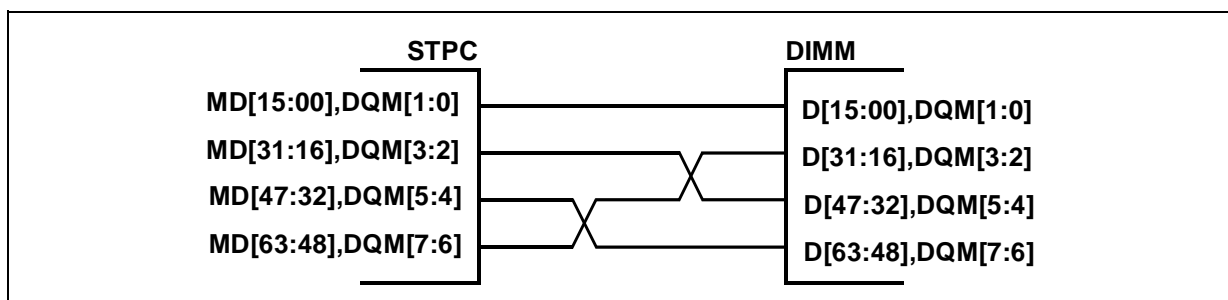
lines could control either 4 single row DIMMs or 2 dual row DIMMs.

When using DIMM modules, schematics have to be done carefully in order to avoid data busses completely crossed on the board. This has to be checked at the library level. In order to achieve layout shown in [Figure 6-12](#), schematics have to implement the crossing described on [Figure 6-13](#). The DQM signals must be exchanged using the same order.

**Figure 6-12. Optimum data bus layout for DIMM**



**Figure 6-13. Schematics for optimum data bus layout for DIMM**



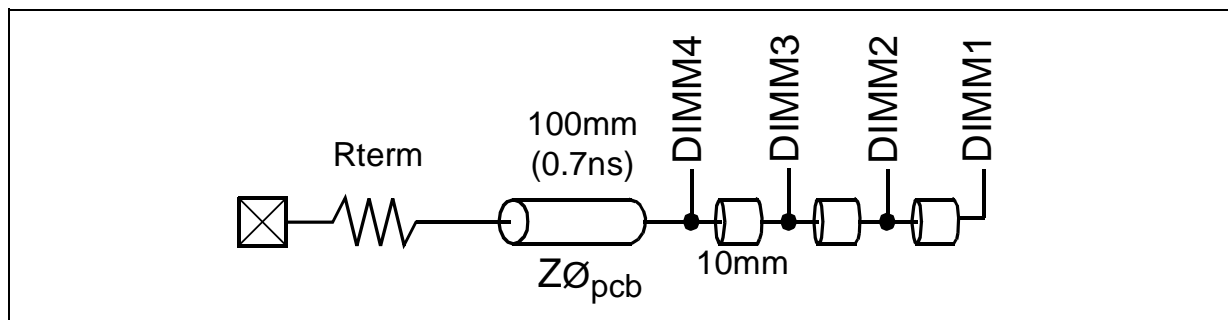
## BOARD LAYOUT

### 6.3.4 Address & Control Signals

This group encompasses the memory address MA[10:0], bank address BA[0], RAS, CAS and write enable WE signals. The load of the DIMM module on these signals is the most important one and depends upon the type of SDRAM compo-

nents used (x4, x8 or x16) and whether the DIMM module is single or dual row. The capacitive loading of the SDRAM inputs alone for an x8 single row DIMM will be about 30-40pF. An equivalent circuit for the timing simulation is shown in [Figure 6-14](#). Most of the delays are due to the PCB traces and loading rather than the pad itself.

**Figure 6-14. Address/control equivalent circuit**

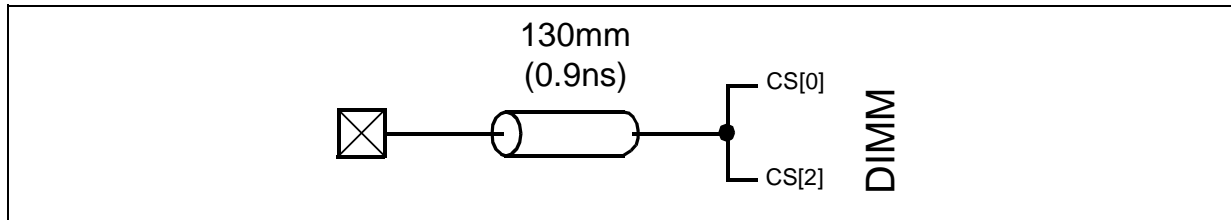


### 6.3.5 Chip Select Signals (CS#[3:0])

There are 4 chip select pins per DIMM. Chip selects 0 and 2 are always used to select the first

row of SDRAMs and chip selects 1 and 3 select the second row on dual bank SDRAMs. The chip select outputs only have to drive one DIMM each

**Figure 6-15. CS# equivalent circuit**



## BOARD LAYOUT

### 6.3.6 Data Write (MD[63:0])

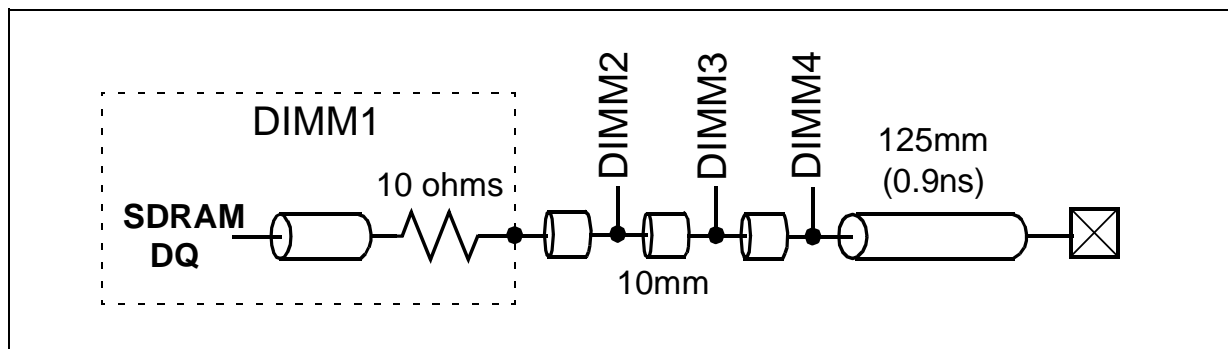
The load on the data signals is much lower than the address/control signals for an unbuffered DIMM. For a registered DIMM the data signals are the only memory pins of the DIMM which are not registered. For the design to get maximum benefit from using registered DIMMs the timings should

be compared to the timings for registered DIMMs for the other pins.

### 6.3.7 Data Read (MD[63:0])

The data read simulation circuit is shown below..

**Figure 6-16. Data read equivalent circuit**



### 6.3.8 Data Mask (DQM[7:0])

The data mask load is quite similar to that of the data signals.

### 6.3.9 Summary

For unbuffered DIMMs the address/control signals will be the most critical for timing. The simulations show that for these signals the best way to drive them is to use a parallel termination. For applications where speed is not so critical series termination can be used as this will save power. Using a low impedance such as 50Ω for these critical traces is recommended as it both reduces the delay and the overshoot.

The other memory interface signals will typically be not as critical as the address/control signals for unbuffered DIMMs. When using registered DIMMs the other signals will probably be just as critical as the address/control signals so to gain maximum benefit from using registered DIMMs the timings should also be considered in that situation. Using lower impedance traces is also beneficial for the other signals but if their timing is not as critical as the address/control signals they could use the default value. Using a lower impedance implies using wider traces which may have an impact on the routing of the board.

## 6.4 SDRAM LAYOUT EXAMPLES

The STPC provides MA, RAS#, CAS#, WE#, CS#, DQM#, BA0 (MA[11]) and MD for SDRAM control. From 2 to 128 MBytes of main memory are supported in 1 to 4 banks. All Banks must be 64 bits wide.

The following memory devices are supported:

4Mbit x 4, 8Mbit x 2 & 16Mbit x 1 or if in the case of two internal bank chips, 2Mbit x 4 x 2, 4Mbit x 2 x 2 & 8Mbit x 1 x 2 .

The following [Figure 6-17](#) and [Figure 6-18](#), shows two possible SDRAM organizations based on one or two bank configurations.

Notes for [Figure 6-17](#) and [Figure 6-18](#);

All buffers must be low skew clock buffers

One clock driver can operate upto four memory chips.

All the clock lines must follow the rules below;

$$MCLKI = MCLK0 + MCLK0A$$

$$= \dots\dots$$

$$= MCLK0 + MCLK0D$$

$$= MCLK1 + MCLK1A$$

$$= \dots\dots$$

$$= MCLK1 + MCLK1D$$

This means that all line lengths must go from the buffer to the memory chips (MCLK1 or MCLK0 or ...) and from the buffer to the STPC (MCLKI) must be identical.

### 6.4.1 Host Address to MA bus Mapping

Graphics memory resides at the beginning of Bank 0. Host memory begins at the top of graphics memory and extends to the top of populated SDRAM.

The bank attributes can be retrieved from a lookup table to select the final SDRAM row and column address mappings. ([Table 6-2](#)). Also [Table 6-1](#) shows the Standard DIMM Pinout for the users that wish to design with DIMMs.

BOARD LAYOUT

Figure 6-17. One memory Bank with eight chips (8-Bit)

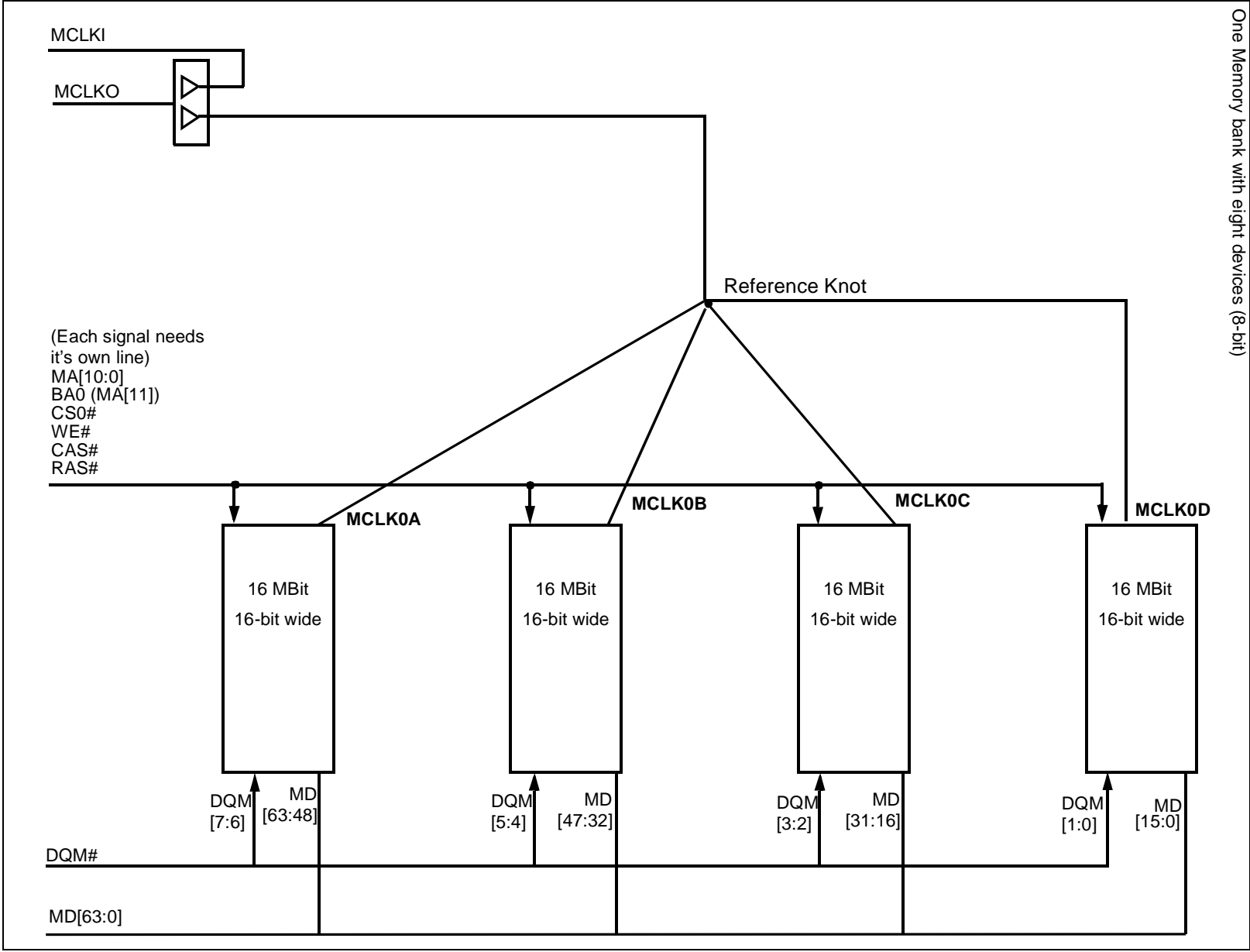
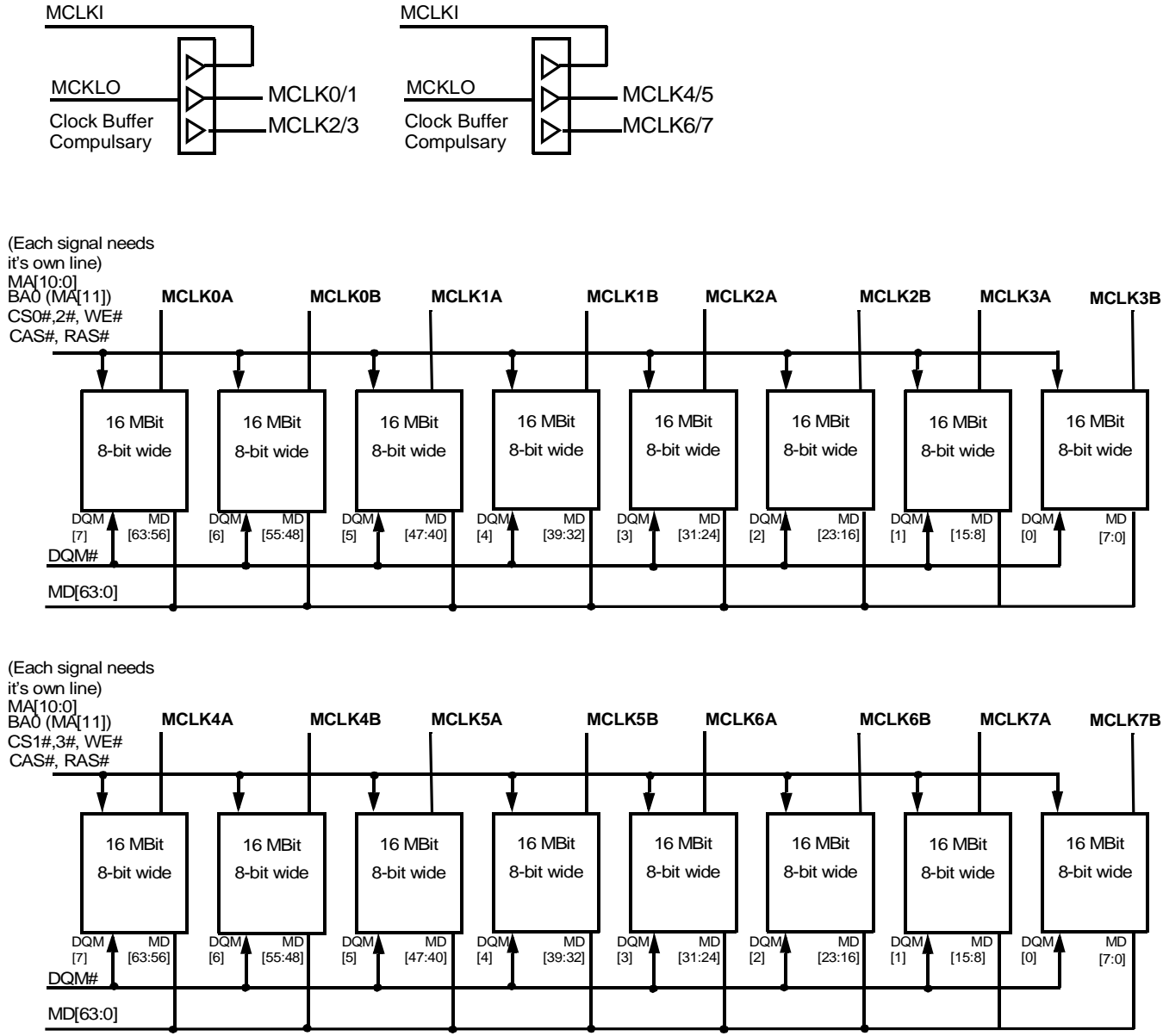


Figure 6-18. Two memory banks with eight chips on each (8-Bit)

Two Memory bank with eight devices (8-bit)



## BOARD LAYOUT

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**Table 6-1. Standard Memory DIMM Pinout**

Memory Banks pin number	16Mbit(2 banks)
...	MA[10:0]
123	-
126	-
39	-
122	BA0(MA11)

**Table 6-2. Address Mapping**

Address Mapping: 16 Mbit - 2 banks												
STPC I/F	BA0(MA11)	MA10	MA9	MA8	MA7	MA6	MA5	MA4	MA3	MA2	MA1	MA0
RAS ADDRESS	A11	A22	A21	A2	A19	A18	A17	A16	A15	A14	A13	A12
CAS ADDRESS	A11	0	A24	A23	A10	A9	A8	A7	A6	A5	A4	A3



## 7 ORDERING DATA

### 7.1 Ordering Codes

	<u>ST</u>	<u>PC</u>	<u>C03</u>	<u>66</u>	<u>BT</u>	<u>C</u>	<u>3</u>
STMicroelectronics Prefix							
Product Family PC: PC Compatible							
Product ID C03: Consumer-S							
Core Speed 66: 66MHz 75: 75MHz 90: 90MHz							
Package BT: 388 Overmoulded BGA							
Temperature Range C: Commercial Case Temperature (Tcase) = 0°C to +100°C I: Industrial Case Temperature (Tcase) = -40°C to +100°C							
Operating Voltage 3 : 3.45V ± 0.3V							

## ORDERING DATA

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### 7.2 Available Part Numbers

Part Number	Core Frequency ( MHz )	CPU Mode ( X1 / X2 )	Tcase Range ( °C )	Operating Voltage ( V )
STPCC0375BTC3	75	X1	0°C to +100°	3.45V ± 0.3V
STPCC0390BTC3	90	X1		

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